Materials Engineering in Product Design + Manufacture

Materials & Methods

DEC 1
EAST ENGINEERING

December, 1954

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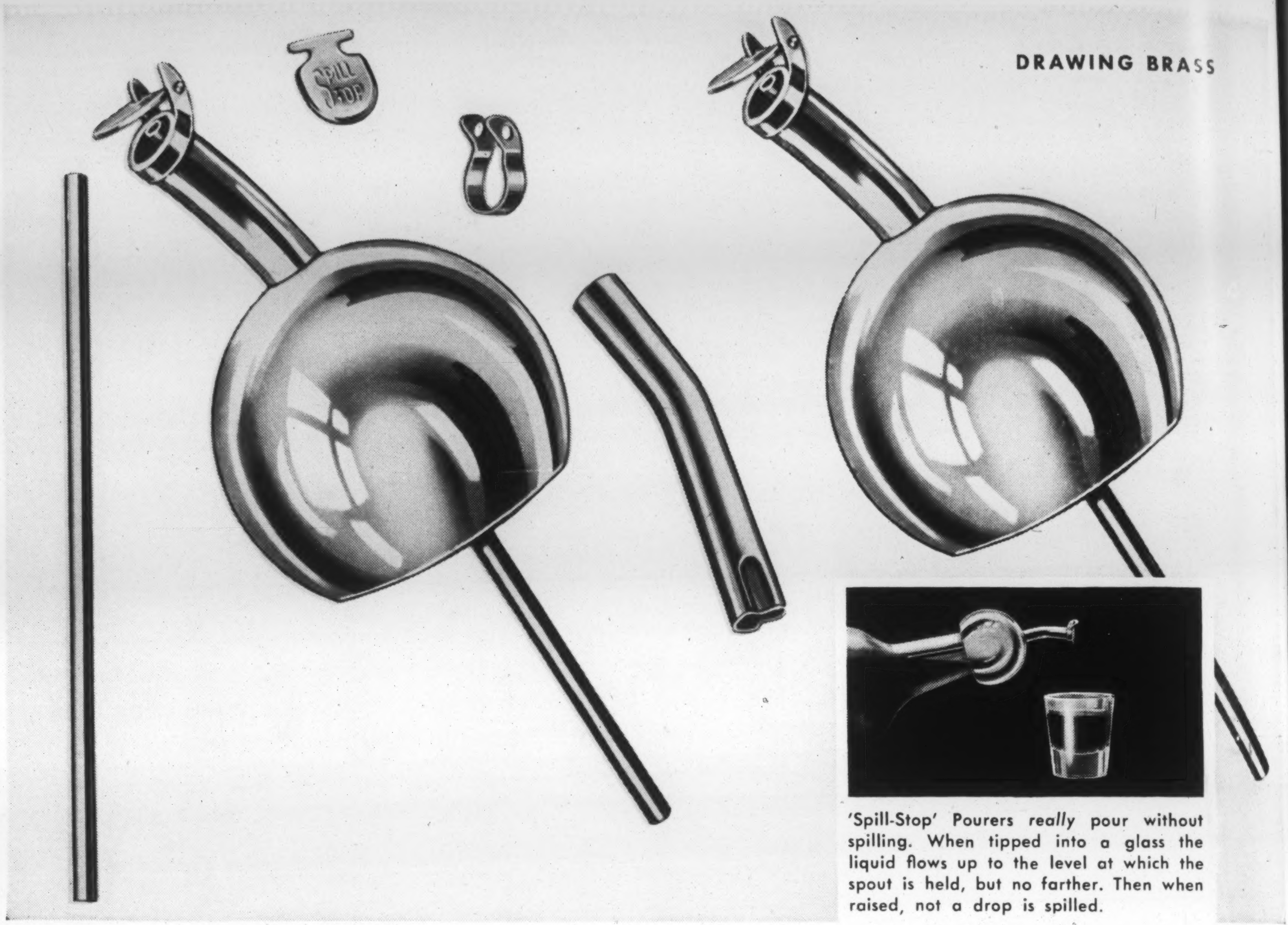

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'Spill-Stop' Pourers *really* pour without spilling. When tipped into a glass the liquid flows up to the level at which the spout is held, but no farther. Then when raised, not a drop is spilled.

BALL OF CHROME DOME and Gold Dome Pourers is made of Formbrite Drawing Brass, either chromium-plated or gold-plated over bright nickel. Tubing is supplied by French Small Tube Branch, an Anaconda subsidiary. Cap and hinge material is furnished by Anaconda's Kenosha Branch.

"When it comes to finishing these 'Spill-Stop' Pourers, there's no comparison between Formbrite and ordinary drawing brass"

—says Spill-Stop Mfg. Co.

Spill-Stop* Manufacturing Company is enthusiastic in its praise for Formbrite*—Anaconda's new drawing brass.

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5491

*Reg. U. S. Pat. Off.

Formbrite

FINE-GRAIN DRAWING BRASS

an ANACONDA® product

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For more information, turn to Reader Service Card, Circle No. 319

Materials Engineering in Product Design + Manufacture

Materials & Methods®

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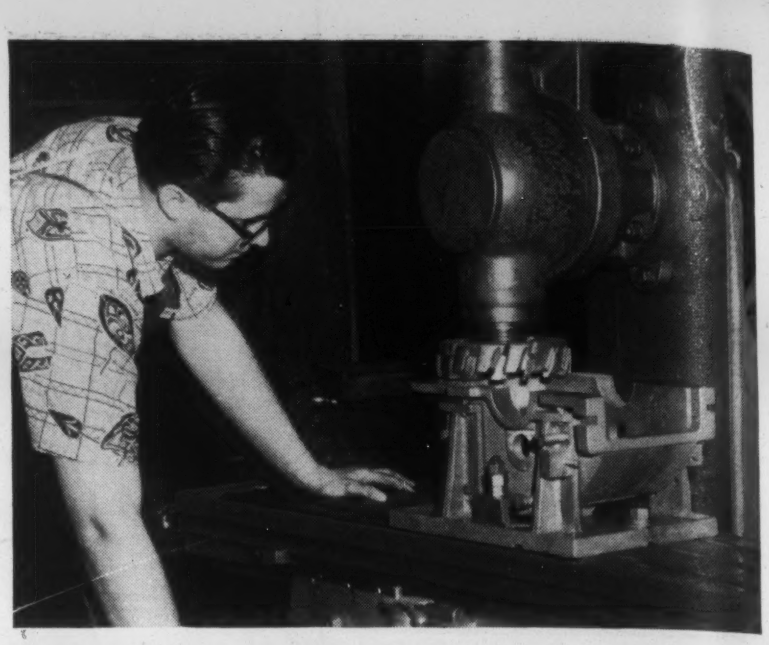
MATERIALS & METHODS IS INDEXED REGULARLY IN THE ENGINEERING INDEX AND THE INDUSTRIAL ARTS INDEX

Where product purity is at stake...

(as in processing color-sensitive plastics
for products like these)

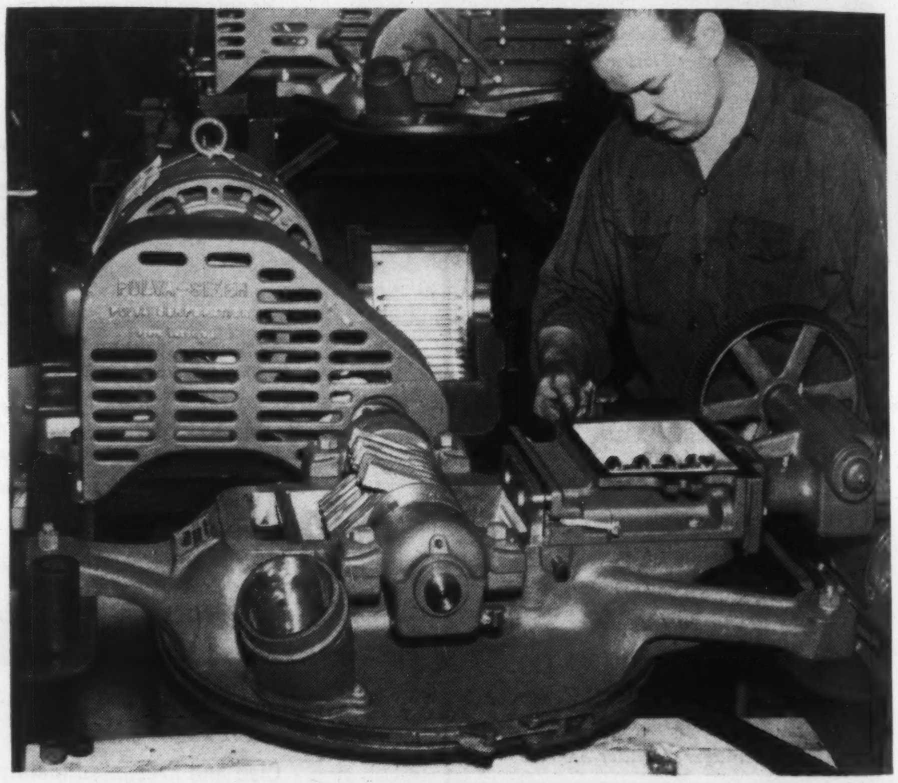


where you need a tough casting...

(for intricate parts like the saran pulverizer housing
being milled above)

...you can rely on Inco-Cast Nickel

(Here, for example, Pulva Corporation is assembling another nickel PULVA-SIZER for processing saran. Previous units, generally operated on a 24-hour-a-day basis, have proved so reliable they have given more than a year of trouble-free service. Twelve Inco-Cast Nickel castings and five other Nickel parts are used in the assembly.



In Inco-Cast Nickel you get both an enduring metal and a sound casting. That's why Inco-Cast Nickel is so useful in an application like this.

In Inco Nickel, you get a metal that will handle polyvinylidene chloride and its copolymers as well as other organics without staining them . . . a metal that doesn't tend to catalyze their decomposition at processing temperatures.

Furthermore, Inco Nickel is a tough, easy-to-machine metal with good all-around physical and mechanical properties . . . strength, corrosion resistance, wear resistance, good appearance. You can weld it readily by any of the standard welding processes using Inco welding materials.

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You can be sure, too, of Inco's extra interest in and experience with its own metals . . . and of Inco's technical assistance.

So where product purity is at stake and you need a metal you can count on to last, put Inco-Cast Nickel high on your list. For complete information, write for Inco's new casting booklet, "Cast to Last."

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inco Castings . . . *Sand, Centrifugal and Precision*

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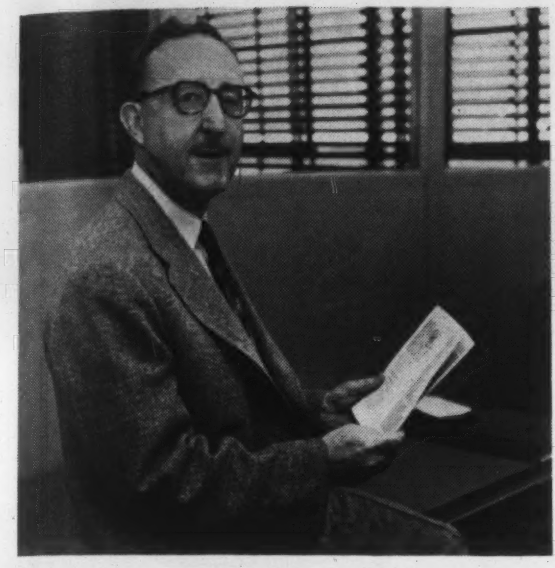
For more information, turn to Reader Service Card, Circle No. 461

Men of Materials...

their views
on development
and utilization
of engineering materials
in industry

Walter E. Jominy

Chief Metallurgist, Research,
Chrysler Corporation



Specialist in ferrous metals, Walter Jominy is known for many important contributions to metallurgy in the fields of heat treatment, hardenability and mechanisms of wear. The most common test for the hardenability of steel bears his name. Mr. Jominy's career has been almost exclusively with the automotive industry since 1916, except for a period of seven years during which he was research engineer at the University of Michigan. He is a past president of the ASM, and has received both the Albert Saveur Achievement Award and Distinguished Service award from that society. He is also active in the SAE and American Foundrymen's Society.

"Metallurgical research in the automotive industry covers a very wide area of interest. Nearly all of the commercial metals are used in the industry and many of them in large volume. The average automobile is over 90% metal, of which by far the largest percentage is steel, cast iron and malleable iron. While there are some differences in automobiles, perhaps a good average of metals other than iron base is about 5%. In this 5% would be such metals as copper, brass, bronze, aluminum, magnesium, zinc, nickel, chromium, babbit, sintered metals, and others. Steel may contain additional elements as silicon, manganese, molybdenum and boron. All in all, this is quite an array of metals with which the automotive metallurgical engineer must have an acquaintance. His researches are not limited to these metals but rather to satisfying certain design requirements. Cost enters importantly into the picture.

"Corrosion resistance at a low cost has been the aim of a good many research projects in the industry. These usually have in view some type of coating—metallic, organic or inorganic. It appears too much to expect that a stainless steel can be produced at a really low price, but this is what is needed. About the cheapest metallic coating is zinc plate which if used in thicknesses of ½ thousandths gives good outdoor protection. When beauty and styling are involved, chromium gets the call. Only about 20 to 50 millionths of an inch of chromium is used over nickel plate. Much research has been carried on to find a substitute for the use of nickel which at times has been unobtainable because of military requirements.

"Wear remains a problem which keeps cropping up and calling for more know-how. The trouble in studying wear is that it is so difficult to simulate service conditions in the laboratory. The common procedure is to make laboratory wear tests which may be duplicated with accuracy and then compare these with dynamometer and proving ground tests using the same materials. This is a long tedious operation which too often results in giving up before pay dirt is reached.

"There are of course a great many other material problems being energetically attacked by the well staffed and equipped laboratories in this industry and much that is worthwhile has come from them."

This advertisement first appeared about a year and a half ago. It is repeated because the customer has since reported that gasket performance in this rugged service proved extremely successful since adopting gaskets made from Revere Deoxidized Copper Tube.

IT PAYS TO CONSULT REVERE.

TO MAKE HEAVY-DUTY COPPER Gaskets USE REVERE DEOXIDIZED Tube!

Diesel Fuel Injection Pump, made by American Bosch Corp., Springfield, Mass., and gaskets made by cutting rings off 2" deoxidized copper tube.

- An important extra service rendered by Revere consists of collaboration in setting up specifications. This is valuable because there are many different Revere Metals, each with special characteristics. No one copper, for example, will serve to best advantage in every application. A case in point is the matter of copper gaskets for Diesel fuel injection pumps. Copper is of course an ideal metal for gaskets, and is widely used for that purpose. But for this special application, which copper and in what form? The pump is used on large engines for municipal generating plants. It weighs 186 pounds, and must produce the high pressure required to inject fuel near the top of the Diesel compression stroke. Naturally, the load is a pulsating one. American Bosch Corporation came to Revere with the problem. Our suggestion was that much scrap could be saved if the gaskets were made by cutting rings off copper tube, instead of stamping them from strip. This achieved a double purpose, since the tube is made of deoxidized copper, which is superior in this application to electrolytic. We are able to report that these recommendations proved successful.... This work was done by the Revere Technical Advisory Service. To get in touch with it, see the nearest Revere Sales Office.

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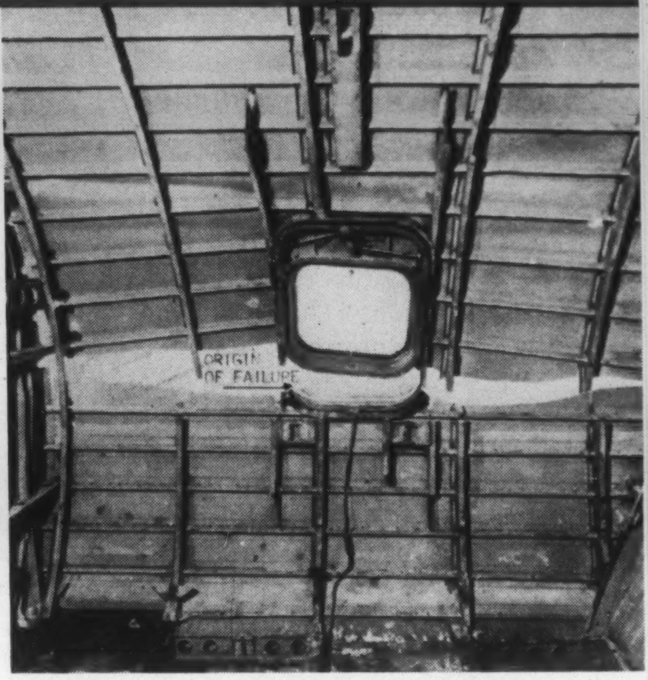
MATERIALS ENGINEERING **News Digest**

Two de Haviland Comet I airliners similar to the one pictured above crashed mysteriously. Preliminary tests indicate metal fatigue in window frames was cause of disasters.



Interior view of Comet fuselage tested to destruction in test tank. Failure originated in escape hatch frame.

Wide World Photos

Jet Airliner Disasters Laid to Metal Fatigue

Metal fatigue and insufficient testing were twin villains in the de Haviland Comet I jet airliner crashes, according to preliminary results of an extensive salvage operation and program of destructive testing to determine the cause of the plane failures.

At a court of inquiry in London, the Royal Aircraft Establishment revealed that a reconstruction of the air disaster from salvage operations indicated that the initial failure of the aircraft structure occurred at the corner of a forward window in the fuselage. Air pressure inside the cabin and the tearing effect of the air stream caused a large section of the fuselage structure to rip away in a decompression explosion similar to a bursting baloon. The BAE estimated that the cabin was emptied of passengers and portable equipment in an incredibly violent period lasting less than 3/10 of one second.

A Rivet and a Notch

The point of origin of failure on one of the Comet I's tested to destruction was a fatigue crack extending from a countersunk rivet in the lower corner of one of a square hatch. The testing program showed that the frame structure, fabricated of DTD 546 aluminum (a clad alloy with tensile strength slightly above 60,000 psi) was subject to repeated intermittent stress of 45,000 psi. Thus a 70% load factor was applied compared to a design factor of a 50% maximum. The stress developed as a result of cabin pressure and wing bending moments.

No Test Indication

In proof-testing the cabin structure under pressurization, de Haviland pushed pressures up to twice the maximums encountered in flight without any sign of failure. After operation of the Comet, however, the airline tested the cabin pressure only up to 11 psi, or one third more than maximum, the Air Registration Board's recommended standard. The total stresses caused by adding flight stress and cabin pressure stress would not show up under such standard testing conditions.

Subsequent Tests

The RAE built a special tank for testing the grounded Comets to destruction and demonstrated that the aircraft structure failed at the window corners in several places after repeated loading. It is expected that Britain's ARB will demand tests to destruction of models of all future jet and turbojet pressurized aircraft before certification.

Setback for Britain

The two Comet crashes, and the subsequent revelation of defective structure, virtually eliminates Comet I jet airliners from consideration for commerical use. They may never even fly again. The Comets II and III, though they have been extensively redesigned, will undoubtedly have to pass much more rigid tests to secure certification. The crashes and widely publicized test results will also set back public acceptance of commerical jets and may result

(Continued on page 12)

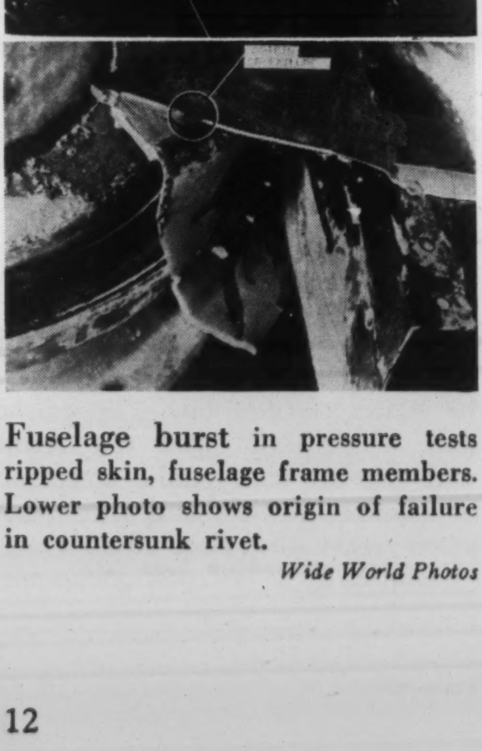
(Continued from page 11)

in hesitancy on the part of commercial airlines to invest in expensive jet equipment.

Attention on Fatigue

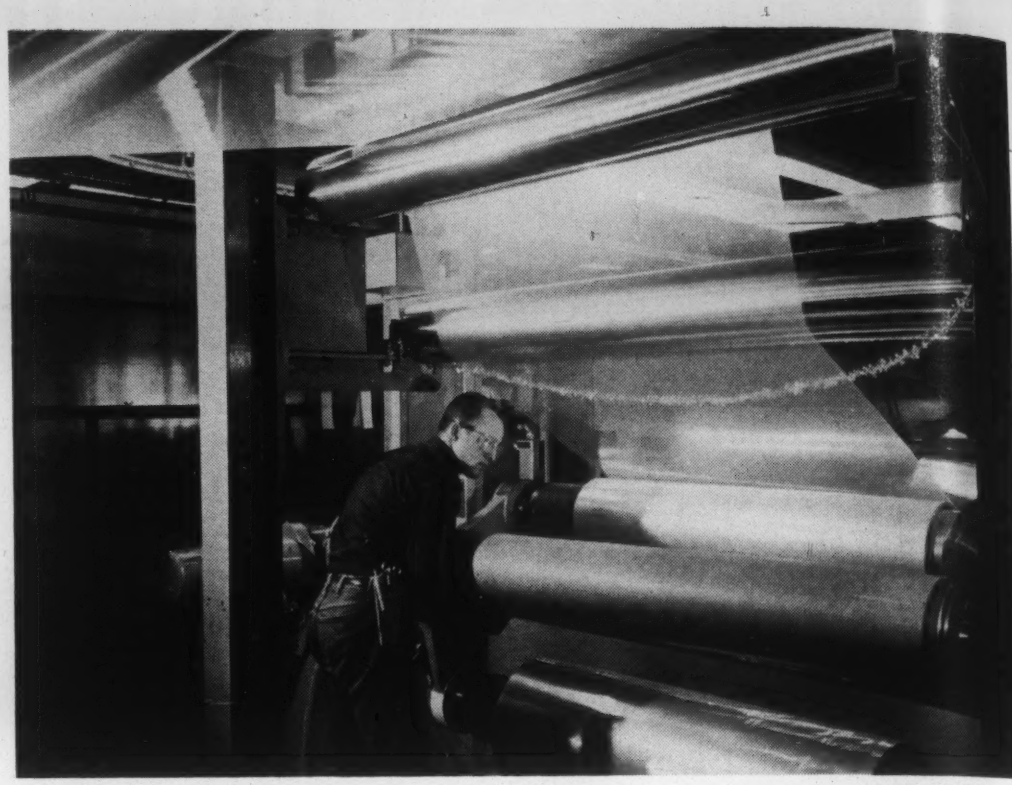
The Comet crash investigations have focused attention on the importance of fatigue to the greatest exent since it has been recognized as an important engineering consideration. The twin Comet disasters, representing as they do such loss of life, money, equipment, engineering prestige, and perhaps even national leadership in commercial jet aviation for Britain, should act as a spur to further all phases of research to broaden the understanding of fatigue and to establish testing techniques to predict failure.

Strictly speaking, the cause of the Comet crashes has not been established conclusively, and may never be, but the investigations have revealed that a fatigue condition existed that was not expected and could not be detected by accepted tests. It is hardly likely that such a disaster will ever happen again, but the crashes present the strongest evidence that designing for modern high speed equipment puts demands on engineering knowledge, design knowledge, and thorough understanding of materials which minimum accepted standards do not meet.



Fuselage burst in pressure tests ripped skin, fuselage frame members. Lower photo shows origin of failure in countersunk rivet.

Wide World Photos



Mylar film emerges in continuous sheet 54 in. wide at du Pont's new plant in Circleville, Ohio.

More Production Equals Lower Costs for Mylar

Considering that the first large scale Mylar plant went into high gear only two months ago, the tough, versatile polyester film is appearing in a great number of high production items. When du Pont's Circleville, Ohio plant completed its 2½ month start up on October 5th, the company immediately cut prices up to 15¢ per lb., putting Mylar in a price range of $2.85 per lb for heavier gages to $4.00 for the lightest gage.

Although Mylar has been available in limited quantities for some time, many large volume users have had to wait for completion of the new plant. Now, textiles, metallized or laminated sheet, magnetic recording tape, and electrical and corrosion resistant products will be increased in volume.

Mylar film has an unusual combination of properties which recommend it for a variety of industrial and electrical uses, so it is hardly surprising that a number of users watched anxiously while du Pont worked the final snags out of its new plant. Mylar has high impact and dielectric strength, and is resistant to moisture, solvents, and many acids and alkalis. It is temperature stable from —60 to 300 F. Laminated on both sides of metal foil and slit, it makes a metallic yarn that is strong, and is unaffected by dry cleaning solvents and ironing temperatures. A vacuum-deposited film of aluminum or Mylar provides a mirror-bright sheet and the material can be bonded to leather, fabric or plastic, and embossed. The material gives a startingly effective appearance of textured, bright-plated, sheet-metal, and will not tarnish or scratch easily. Designers at Chrysler Corp. were so impressed with the metallized sheet that they decided to use it in the interior of several 1955 Dodge models even though they were not absolutely guaranteed of adequate supply until less than a month before the new models were introduced.

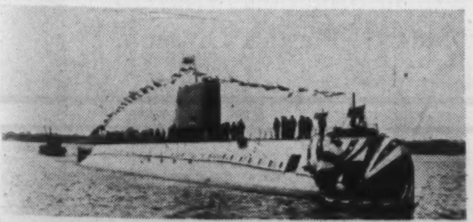
An unusual experimental application of the polyester film is laminating it to metals and then drawing the metals to shape, eliminating lacquering or tin plating.

The material is available in gages ranging from 0.00025 in. to 0.0075 in. in rolls in widths ranging from ½ to 54 in.

A-Sub Plumbing A Stockroom Error

The failure of a $1\frac{1}{2}$-in. steam line on the $55 million nuclear powered submarine *Nautilus* has regenerated arguments on the relative merits of welded and seamless tubing. Initial press reports flatly attributed the failure to welded pipe, and reported that the entire steam system of the submarine was to be torn out and replaced with seamless tubing. While the failure did occur in a welded steam line, investigation showed that the shipbuilder's stockroom had accidentally substituted non-pressure pipe in place of the specified high temperature pressure grade. Thus, the implication that welded pipe was at fault is actually an unjust oversimplification of the accident.

By error, non-pressure steel pipe made to ASTM specification A53 was pulled from stock instead of A106, a higher grade carbon steel pipe designed for high temperature service. A53 pipe can be either welded or seamless, whereas Spec A106 covers only seamless pipe. Both welded and seamless pipe of the A53 grade were used in the Nautilus installation, but the fact that the failure occurred in a welded pipe led to the incorrect implication in press reports that welded pipe is not suitable for pressure use. Actually, as experts in the field of pressure piping point out, welded pipe of the proper quality and made to correct ASTM specifications is more than adequate for service more severe than the *Nautilus* installation. For example, carbon steel welded piping made to ASTM Spec. A155 handles temperatures as high as 850 F at pressures of the order of 750 psi. The *Nautilus* piping was a secondary steam line (not part of the nuclear power plant) with considerably lower pressure and temperature. The shipbuilder is replacing the pipe in the *Nautilus* at his own cost.



USS Nautilus on the day of her launching. New pipe installation will delay ship's completion.

TAYLORCRAFT
TAYLORCRAFT

Plastic-skinned Taylorcraft resembles conventional light plane, but is faster and is easier to build.

Plastic-Skinned Lightplane Has Improved Performance

The first plastic-skinned commercial lightplanes took to the air last month with remarkably little fanfare. While industry rumors have attributed the development of an "all plastic" plane to several lightplane builders, Taylorcraft's are the first in the air, and will be the first in commercial production.

Rumors to the contrary, the new four passenger Taylorcraft is far from all-plastic. Steel tubing, spruce and aluminum form the main structural members of the wing and fuselage, as in conventional fabric or stressed-aluminum covered craft. The plastic is literally a skin bolted or riveted to the airframe. The skin is formed by hand lay-up in plaster molds.

Cites Advantages

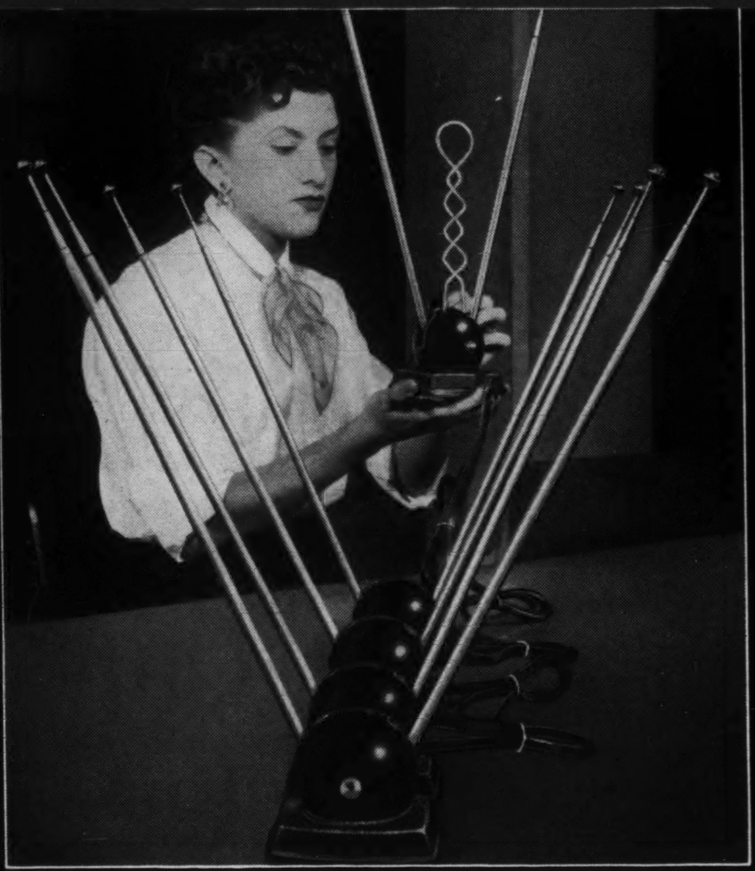
B. J. Mauro, president of Taylorcraft, said that initial tests of the new planes indicate that the tough glass fiber-reinforced polyester skin will give much better service than either aluminum or doped fabric. The plastic is less subject to damage, since it is more resistant to denting, tearing, or warping. Repair of minor damage is as simple as patching

(Continued on page 210)

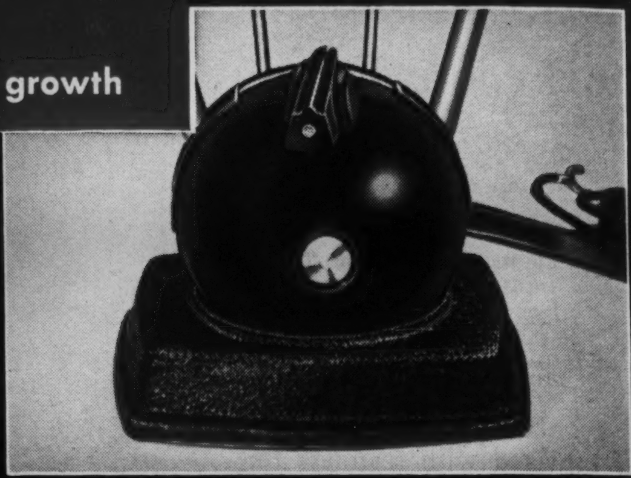
Reflected on smooth surface of all-plastic T-6 wing, Air Force engineers discuss performance chart.

Air Force Photo

THE DESIGNER AND ENGINEER:
pioneers of improved products for company growth



Interior antenna is inspected. Bases of Lustrex Hi-Test 88 styrene plastic are molded in halves. A pole is then inserted in each half, connections are secured, and one master bolt completes fast, easy assembly.



"Vee Ball" base (Above) and "Clock-tenna" (Below) are molded by Leaf Molding Company, who also supply RMS with insulators for outside antennae, made of Lustrex styrene.

After other materials fail, RMS designers solve TV antenna problem with

HI-TEST 88
MONSANTO
LUSTREX®
Styrene Plastic

Seeking the best possible material for bases and insulators to be used on their inside and outside aerials, Radio Merchandise Sales, Inc., set up these rigid requirements: excellent insulating properties; unusual tensile strength; superior impact resistance; weatherability and water-resistance; design flexibility; wide color range; adaptability to mass production; low unit cost; elasticity; and impressive sales appeal. Other materials failed to meet this combination of "musts." *Only Lustrex Hi-Test 88 styrene plastic passed all tests with flying colors.*

This successful application typifies the results designers and production men are obtaining with Lustrex Hi-Test 88 styrene. It dramatizes, too, the many new applications possible with a material having such a range of outstanding characteristics. Perhaps Lustrex, or another of Monsanto's family of plastics, can help solve your design and production problems. For information write to MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2212, Springfield 2, Mass.

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DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 9

CHOOSING AN ALUMINUM CASTING ALLOY & HEAT-TREATMENT

CHOOSING the proper aluminum casting alloy and heat-treatment requires a complete knowledge of the service conditions of the part under consideration, as well as of the alloys, heat treatments, and various casting methods in common use.

There are over thirty recognized casting alloys, with as many as five different heat-treatment possibilities for some, which results in quite a formidable number of choices. From these available alloy and heat-treatment combinations the possible range of typical mechanical properties varies widely as can be seen in the following table:

TABLE 1 Range of Mechanical Properties of Cast Aluminum Alloys

Ult. Tensile Strength . . .	19,000 to 46,000 PSI
Yield Strength	8,000 to 43,000 PSI
Elongation	Zero to 14% in 2"
Fatigue	5,500 to 23,000 PSI
Brinell Hardness	40 to 140

The physical properties likewise, vary over a broad range as shown below:

TABLE 2 Range of Some Physical Properties of Cast Aluminum Alloys

General foundry characteristics	Fair to Excellent
Susceptibility to hot-shortness	Appreciable to Very Little
Ability to be cast in thin sections	Fair to Excellent
Leak tightness	Fair to Excellent
Internal shrinkage	Considerable to Very Little
Machinability	Fair to Excellent
Weldability	Not Recomended to Excellent
Resistance to certain chemicals and compounds	Can't use to Recommended
Strength at elevated temperatures	Low to Moderate
Resistance to corrosion	Fair to Excellent
Impact, or shock-load resistance	Poor to Excellent
Thermal conductivity	.21 to .45 CGS units @ 25°C
Electrical conductivity	21 to 50% of copper (equal volume basis)
Stability to low temperature aging	Low stability to stable

Because of this wide range of properties from which to select, it is recommended that the alloy and heat-treatment be determined by the designer, rather than by the foundryman, because usually the designer has all the data which affect the choice. The foundry should be consulted, but should not be the sole judge. Other factors, each equally as important as foundry characteristics, enter into the alloy and heat-treatment selection.

The designer usually knows which property is required to the fullest extent for the part in question. This should, theoretically, make it fairly easy to select the correct combination from the tables, by merely choosing the one that has the desired property to the maximum degree. But unfortunately, castings having the desired ultimate strength for instance, may not have the required elongation or shock resistance, nor the desirable foundry characteristics. Another having the desired foundry characteristics may not have the required strength and machining properties.

Still another combination may have the required mechanical properties, foundry characteristics and corrosion resistance, but because of size and shape of casting, cannot be given the theoretically ideal heat-treatment. Compromises will have to be made in almost all cases and this can best be done by the designer. In fact, it will sometimes be necessary to actually change the design of part in order to make it adaptable for production in a given alloy and heat-treatment or to cast it by a certain process.

Factors to Consider

To enable the designer to make best alloy and heat-treat recommendations, he should be familiar with production and service requirements. He should also have a fair working knowledge of the aluminum alloys, heat treatments, and of the possibilities and limitations of the various casting processes.

The production and service requirements have a large bearing on the casting method, as do size and shape of part. For example, castings required in fairly large numbers, should be made either by permanent mold or die casting process, provided the size and design features of casting and available alloys are suitable.

Sand casting process is usually confined to producing parts required in small quantities, those having hollow cavities and complex arrangement of ribs, pockets, etc., and to those whose size makes them unsuited for casting in metal molds. In many cases it will be advantageous to redesign a part to make it adaptable for production by either permanent mold or die casting method.

Once the casting method is determined, the alloy choice is narrowed down appreciably.

Next to be considered are the service requirements. If high strength is necessary, that ordinarily eliminates the unheat-treatable alloys unless sufficient metal can be added to compensate for the lower mechanical properties. This can be further and rapidly narrowed down when the remaining requirements such as leak tightness, corrosion resistance, machinability and others are considered.

In some instances, one certain property may be required to the maximum degree—for example, highest possible yield. This immediately narrows down the alloy and heat treatment choice as well as casting method to a possible one or two, and bigger compromises will have to be made for the other requirements.

In other cases the large size and shape of casting may not permit the safe use of a "solution heat-treatment," but will limit it to use of a "straight aging treatment" taking place in approximate temperature range of 300° F to 500° F, or to no treatment at all, thereby sacrificing, to a degree, some of the mechanical properties and slightly decreasing machinability.

The reason for this limitation is the fact that the first half of a solution heat-treatment takes place at a temperature ranging between 930° F to 1,000° F, followed by rapid quench in water. At those temperatures, the mechanical strength of aluminum is practically zero and therefore certain large unsupported areas of the casting, or the whole casting at times, may sag or distort from its own weight. Sometimes the size and shape of part are such that it can withstand the effects of the high temperatures but cannot be quenched without danger of warping or cracking.

Die castings are always used in the as-cast condition, which limits the choice to one of alloy selection only.

To assist the designer in becoming familiar with the various casting processes, mechanical properties, and physical properties we refer him to these tables on the following pages:

Table #3—Typical Mechanical Properties of Aluminum Sand Castings

Table #4—Typical Mechanical Properties of Aluminum Permanent Mold Castings

Table #5—Typical Mechanical Properties of Aluminum Die Castings

Table #6—Alloy selection Guide

PLEASE TURN TO NEXT PAGE ➡

SAND CASTING ALLOYS—TABLE 3

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2″	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	19,000	8,000	8.0	40	6,500	E	E	VL	E	F	E	VG
108	AC	21,000	14,000	2.5	55	8,000	E	E	MIN	VG	G	G	G
112	AC	24,000	15,000	1.5	70	9,000	F	F	MOD	G	G	G	F
113	AC	24,000	15,000	1.5	70	9,000	G	G	MOD	G	G	G	G
122	T2	27,000	20,000	1.0	80	9,500	G	VG	MOD	G	E	F	F
122	T61	41,000	40,000	(6)	115	8,500	G	VG	MOD	G	E	F	F
142	T21	27,000	18,000	1.0	70	6,500	G	F	AP	F	G	G	F
142	T571	32,000	28,000	.5	85	8,000	G	F	AP	F	G	G	F
142	T77	28,000	25,000	2.0	75	9,500	G	F	AP	F	G	G	F
195	T4[4]	32,000	16,000	8.5	60	6,000	G	G	AP	F	G	G	F
195	T6	36,000	24,000	5.0	75	6,500	G	G	AP	F	VG	G	F
195	T62	40,000	30,000	2.0	90	7,000	G	G	AP	F	E	G	F
212	AC	23,000	14,000	2.0	65	8,000	G	G	MOD	G	E	G	G
214	AC	25,000	12,000	9.0	50	5,500	F	F	MOD	F	E	E	G
B214	AC	20,000	13,000	2.0	50	....	G	F	MOD	F	E	E	G
F214	AC	21,000	12,000	3.0	50	....	G	F	MOD	F	E	E	G
220	T4	46,000	25,000	14.0	75	7,000	F	F	MOD	F	E	E	G
319	AC	27,000	18,000	2.0	70	10,000	G	E	VL	VG	G	G	G
319	T6	36,000	24,000	2.0	80	10,000	G	E	VL	VG	G	G	G
355	T51	28,000	23,000	1.5	65	7,000	E	E	VL	E	E	VG	VG
355	T6	35,000	25,000	2.5	80	8,500	E	E	VL	E	E	VG	VG
355	T61	39,000	35,000	1.0	90	....	E	E	VL	E	E	VG	VG
355	T7	38,000	36,000	0.5	85	8,500	E	E	VL	E	E	VG	VG
355	T71	35,000	29,000	1.5	75	10,000	E	E	VL	E	G	VG	VG
356	T51	25,000	20,000	2.0	60	7,500	E	E	VL	E	G	E	VG
356	T6	33,000	24,000	4.0	70	8,000	E	E	VL	E	G	E	VG
356	T7	34,000	30,000	2.0	75	....	E	E	VL	E	E	E	VG
356	T71	28,000	21,000	4.5	60	....	E	E	VL	E	G	E	VG

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—applies to Hot-Shortness only.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.
6. Less than 0.5% elongation.

PERMANENT MOLD CASTING ALLOYS—TABLE 4

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Percent in 2"	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	23,000	9,000	10.0	45	....	E	E	VL	E	F	E	VG
A108	AC	28,000	16,000	2.0	70	....	E	G	MIN	VG	G	G	G
113	AC	28,000	19,000	2.0	70	....	F	G	MOD	F	G	F	F
C113	AC	30,000	24,000	1.0	80	9,500	G	VG	VL	G	G	G	G
122	T52	35,000	31,000	1.0	100	....	G	G	MOD	G	E	F	F
122	T551	37,000	35,000	......	115	8,500	G	G	MOD	G	E	F	F
122	T65	48,000	36,000	......	140	9,000	G	G	MOD	G	E	F	F
A132	T551	36,000	28,000	.5	105	13,500	F	VG	VL	F	F	G	G
A132	T65	47,000	43,000	.5	125	....	F	VG	VL	F	F	G	G
D132	T5	36,000	28,000	1.0	105	13,500	G	VG	MIN	G	F	G	G
138	AC	30,000	24,000	1.5	100	....	....	VG	....	....	G	....	....
142	T571	40,000	34,000	1.0	105	10,500	F	F	AP	F	VG	G	F
142	T61	47,000	42,000	.5	110	9,500	F	F	AP	F	VG	G	F
B195	T4[4]	37,000	19,000	9.0	75	9,500	F	F	MOD	F	G	G	G
B195	T6	40,000	26,000	5.0	90	10,000	F	F	MOD	F	G	G	G
B195	T7	39,000	20,000	4.5	80	9,000	F	F	MOD	F	G	G	G
A214	AC	27,000	16,000	7.0	60	....	F	F	AP	F	E	E	G
319	AC	34,000	19,000	2.5	85	....	G	G	VL	G	G	G	G
319	T6	40,000	27,000	3.0	95	....	G	G	VL	G	G	G	G
333	AC	34,000	19,000	2.0	90	14,500	G	G	VL	G	F	G	G
333	T5	34,000	25,000	1.0	100	12,000	G	G	VL	G	F	G	G
333	T6	42,000	30,000	1.5	105	15,000	G	G	VL	G	F	G	G
333	T7	37,000	28,000	2.0	90	12,000	G	G	VL	G	F	G	G
355	T51	30,000	24,000	2.0	75	....	E	E	VL	E	VG	VG	VG
355	T6	43,000	27,000	4.0	90	10,000	E	E	VL	E	VG	VG	VG
355	T62	45,000	40,000	1.5	105	10,000	E	E	VL	E	E	VG	VG
355	T7	40,000	30,000	2.0	85	10,000	E	E	VL	E	VG	VG	VG
355	T71	36,000	31,000	3.0	85	10,000	E	E	VL	E	VG	VG	VG
356	T6	40,000	27,000	5.0	90	13,000	E	E	VL	E	G	E	VG
356	T7	33,000	24,000	5.0	70	11,000	E	E	VL	E	G	E	VG
363	AC	35,000	23,000	2.7	85	....	E	VG	VL	E	E	G	E
363	T6	48,000	28,000	6.5	90	....	E	VG	VL	E	E	VG	E

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—applies to Hot-Shortness only.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.

DIE CASTING ALLOYS—TABLE 5

		Typical Mechanical Properties[1]					Casting and Service Characteristics[2]					
Alloy	Condition[3]	Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinell 10/500	Fatigue psi	Mold Filling Capacity	Hot-Shortness	General Castability	Machin-ability	Corrosion Resistance	Weld-ability
13	AC	39,000	21,000	2.0	---	19,000	VG	VL	VG	F	VG	not recommended
A 13	AC	35,000	16,000	3.5	---	....	VG	VL	VG	F	VG	
43	AC	30,000	16,000	9.0	---	17,000	G	MIN	G	F	VG	
85	AC	40,000	24,000	5.0	---	22,000	G	MOD	G	F	VG	"
218	AC	45,000	27,000	8.0	---	23,000	F	AP	F	E	E	"
360	AC	44,000	27,000	3.0	---	19,000	E	VL	E	F	G	"
A360[4]	AC	41,000	23,000	5.0	---	18,000	E	VL	G	F	E	"
380	AC	45,000	26,000	2.0	---	20,000	VG	MOD	G	G	G	"
A380[4]	AC	46,000	25,000	3.0	---	19,000	VG	MOD	G	G	G	"
384	AC	46,000	27,000	1.0	---	21,000	VG	MOD	G	F	G	"

NOTES:

1. Properties determined from standard test bars cast under favorable conditions.
2. Ratings: E, excellent; VG, very good; F, fair—apply to all castings and service characteristics except "hot-shortness"; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—apply to "hot-shortness" only.
3. As cast.
4. In A360 and A380, the iron content is controlled more closely than in 360 and 380 alloys.

SELECTION GUIDE—TABLE 6

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
General purpose—Low strength arranged in order of decreasing castability	43 108 112 113 212 214	43 A108 113 C113 A214	43 A 13 13
General purpose—Heat-treated[1] good balance of all properties for most applications	355-T6 356-T6 319-T6 19-ST6	355-T6 356-T6 319-T6 B19-ST6	380 A380 85 360 A360
Best castability for complex castings with thin sections—arranged in order of decreasing castability	43 108 356 355	43 A108 356 355	A360; 360 A 13; 13 43
High ductility and **shock resistance** arranged in order of decreasing properties	220-T4 195-T4 356-T6 214[2] 43	363-T6 B195-T4 356-T6 A214 43	218 A360 85 43
Pressure tight—Low stressed	43 108 319	43 A108 319	A360 A 13 43
Pressure tight—High stressed	356 355 319	356 355 319 363	A360

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
Corrosion Resistance	43 214 220 356 355	43 A214 356 355 363	218 A360
Ornamental and Architectural Applications—also food handling, dairy equipment, cooking utensils and marine fittings	43 214[2] B214[2] F214[2]	43 A214[2]	43 218[2]
Piston Alloys—good properties at operating temperatures	122 142	122 A132 D132 142	384 85
Other alloys having good properties at moderate temperatures	214	138 A214	13 360
Good machinability—Heat-treated castings machine better than those in as-cast condition, and generally those having highest hardness machine better than the softer ones in any one alloy	112 122 212 214 B214 F214 220-T4 195	122 355 363 A214 A108	218 380 A380

NOTES:

1. Except die castings.
2. These alloys take anodized finish without appreciable discoloration.

Kaiser Aluminum

More detailed assistance with design, alloy selection, fabrication, and heat-treatment procedure is obtainable through any Kaiser Aluminum sales office located in principal cities, or write to Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

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MANUFACTURERS' LITERATURE

Stainless Pipe and Tubing. Babcock & Wilcox Co., Tubular Products Div., 4 pp, Technical Data Card No. TDC 162. Outlines welding characteristics of austenitic and ferritic grades of stainless steels. Includes table of recommended arc welding procedures. (20)

Indicating Extensometer. Baldwin-Lima-Hamilton Corp., 8 pp, ill, No. 4212. Description of various types of extensometers with specifications. (21)

Hardness Tester. Barber-Colman Co., 2 pp, ill, No. F 1689-2. Portable hardness tester for aluminum, aluminum alloys, soft metals and plastics. May be used on fabricated parts as well as raw stock. (22)

Aircraft Contract Forming. Cyril Bath Co., 12 pp, ill. Describes plant's facilities for stretch forming, compression forming or radial draw forming. (23)

Bronze Bearings. Bound Brook Oil-less Bearing Co., 20 pp, ill, Stock List No. 4. Lists more than 600 sizes of oil-retaining porous bronze bearings. Information on applications, installation, lubrication and machining. (24)

Optical Plastic Sheet. Cast Optics Corp., 4 pp, ill. Applications of optical plastic sheet cast to close tolerances. (25)

Stainless Steel Welding. Crucible Steel Co. of America, 16 pp. How to select proper grades of welding rod for a given grade of stainless steel. Recommended ranges for A.C. and D.C. welding. Diagrams illustrate leading types of welding joints and basic arc and gas weld symbols. (26)

Metal Cleaning and Processing. Detrex Corp., 8 pp, ill. Industrial washers for a variety of cleaning operations. (27)

Polyester Film. E. I. du Pont de Nemours & Co., Inc., Film Dept., 8 pp, ill. Properties and proposed applications of Mylar listed in convenient chart form. (28)

Protective Coating. Gates Engineering Co., 4 pp, ill. Uses and application of air-curing, liquid neoprene protective coating that can be applied by brush or spray and eliminates use of accelerator. (29)

Precision Parts. General Tire & Rubber Co., Industrial Products Div., 16 pp, ill. Describes company's facilities for producing precision parts in rubber and plastics. (30)

Polystyrene Sheet. Gilman Bros. Co., 4 pp, ill. High impact strength polystyrene sheet for vacuum-forming. (31)

Zinc Alloy Die Castings. Gries Reproducer Corp., 4 pp, ill. Stock list of company's small die castings. (32)

Mechanical Metal Finishing. Hanson-Van Winkle-Munning Co., 4 pp, ill, No. MF-100. Describes processes and equipment used for mechanical metal finishing. (33)

Keying and Pinning. John Gillen Co., Inc., 4 pp, ill. Machined keys and pins for production assembly. (34)

Polyester Resins. Hooker Electrochemical Co. Folder of data sheets describing fire-resistant polyester resins. (35)

Blind Rivets. Huck Mfg. Co., 4 pp, ill. Self-plugging rivets eliminate need for skilled labor after initial cutting, shaping and fitting. (36)

Magnet Testing. Indiana Steel Products Co., 12 pp, ill, Vol. 2, No. 5. Article discusses methods for testing permanent magnets. (37)

Bronze Bars. Johnson Bronze Co., 4 pp, ill. Completely machined 13-in. bars for bearings, bushings, thrust plates and washers. Other applications and machining data listed. (38)

Metal Cleaning. Kelite Products, Inc., 6 pp, ill. Discusses various types of cleaning for finishing requirements. (39)

Cold-Finished Steel Bars. La Salle Steel Co., 12 pp, ill. Facilities for producing cold drawn or turned carbon and alloy steel bars. (40)

Weldless Rolled Rings. Ladish Co., 4 pp, ill. Advantages and applications of high strength weldless rolled rings produced in weights up to 20 tons. (41)

Weldments. Lewis Welding & Engr. Corp., 20 pp, ill. Describes facilities for producing weldments, plastic injection molding machines, and die casting machines. (42)

Heavy Steel Heads. Lukens Steel Co., 4 pp. Stocklist of company's supply of heads. (43)

Protective Coatings. Magic Chemical Co. Revised catalog describes "Magic-Vulc" abrasion-resistant rubber lining and its applications. (44)

Welding Nuts. Midland Steel Products, Inc., 4 pp. Self-locating nuts for faster assembly where nut is welded to plate. (45)

Furnace and Oven Controls. Minneapolis Honeywell Regulator Co., 44 pp, ill, No. 54-1. Catalog and price list on Brown Instruments and Honeywell controls for industrial furnace and oven equipment. (46)

Heat Treating. Misco Fabricators, Inc., 4 pp, ill. List of heat-resisting alloy and stainless steel process equipment. (47)

Formed Copper Tubing. Mueller Brass Co., 8 pp, ill. Various types of copper tubing formed to customer specifications. (48)

Powdered Metal Bearings. National Molded Products, Inc., 60 pp, ill. Describes process, design factors and specifications for cylindrical and flanged bearings. Stock list. (49)

Blast Cleaning and Dust Control. Pangborn Corp., 15 pp, ill, No. 225. Specifications and dimensions for Blastmaster equipment, designed specifically for batch blast cleaning of castings, forgings and heat treated parts. (50)

Die Castings. Paramount Die Casting Co., 4 pp, ill. Describes facilities and services and shows representative aluminum, magnesium and zinc castings. (51)

Metal Cleaners. Park Chemical Co., 4 pp, ill, No. E-1. How to select the proper metal cleaners for heat treatment and finishing operations. (52)

Porcelain Enameling. Pemco Corp., 8 pp, No. 2002. How to prepare aluminum stock for porcelain enameling. (53)

Phosphor Bronze Strip. Penn Precision Products, Inc., 4 pp, No. 4. Information on precision-rolled, close-tolerance strip in Grades A and C. Discussion of temper selection and tables covering specification and engineering properties. (54)

Polystyrene Machining. Precision Metalsmiths, Inc., 4 pp. How to machine polystyrene patterns for investment cast prototypes for testing a design before tooling. (55)

Rigid Metals. Rigidized Metals Corp., 16 pp, ill. Light-weight, high strength rigidized strip and sheet available in ferrous or nonferrous metal. (56)

Metal Surface Finishing. Roto-Finish Co., 6 pp, ill. Folder describes precision finishing process and various types of machines developed for diverse job requirements. (57)

Adhesives. Rubber & Asbestos Corp., 12 pp, ill, No. 110. Two charts list lamination adhesives for 26 laminating materials; check list of end use properties; characteristics for specific job applications. (58)

Zinc Die Casting. St. Joseph Lead Co., 24 pp, ill. Discusses role of zinc as a base metal for die casting alloys and lists the variety of commercial finishes for zinc base die castings. (59)

Investment Castings. Scott Casting & Mfg. Co., 20 pp. Explanation of lost wax process. Limitations, sizes and weights of parts, castable metals and alloys. General information on costs and applications. (60)

Plastic Lined Pipe and Tubing. Saran Lined Pipe Co., 32 pp, ill. Corrosion-resistant plastic with good mechanical strength and inert characteristics for pipe and tube lining. (61)

Industrial Fiber. Spaulding Fibre Co., Inc., 38 pp, ill. List of physical properties, uses and engineering reference data for vulcanized fiber and reinforced plastic sheet. (62)

Beryllium Copper Tubing. Superior Tube Co., 9 pp, No. 7-2. Describes tubing which can be formed cold in the soft annealed or slightly work-hardened condition. Properties and applications given. (63)

Heat Treating. Surface Combustion Corp., 4 pp, ill, No. SC-166. Describes furnaces for heat treating nonferrous metals and alloys. Includes information on controlled atmosphere processing. (64)

Liquid Polymer Epoxy Adhesives. Thiokol Chemical Corp., 16 pp. Starting formulations, properties and methods of application of "Thiokol" high shear strength epoxy resin. (65)

Super-Alloys. Universal-Cyclops Steel Corp., 20 pp, ill. High-strength, corrosion-resistant alloys for gas turbines, turbo-superchargers, rockets and guided missiles. (66)

High Strength Steel. U.S. Steel Corp., 46 pp, ill, No. ADVL-317-54. Properties and fabrication data for Carilloy T-1, new high strength weldable steel with exceptional toughness. (67)

Free Machining Tool Steels. Vanadium-Alloys Steel Co., 6 pp, ill. Uses, compositions, heat treatment and cost of company's representative grades of free machining high-speed tool and die steels. (68)

High-Strength Bolts. U. S. Steel Supply, Div. of U. S. Steel Corp., 6 pp. Describes process of high-strength structural bolting for stronger steel joints. Specifications included. (69)

Low-Temperature Processing. Webber Co., Inc., 4 pp, ill. Freezing chambers for material shrinking, stabilization and production testing. (70)

Other Available Literature

Irons and Steels • Parts • Forms

Metal Products. Allied Metal Specialties Inc., 4 pp, ill. Illustrates a variety of trays, racks, fixtures, tanks, crates, baskets, etc. produced by this company. (71)

Flexible Tubing. American Hard Rubber Co., 4 pp, ill, No. 66-D. Physical properties, chemical resistance, standard sizes and characteristics of transparent plastic tubing. (72)

Metal Powder Parts. American Sinterings, Div. of Engineered Plastics, Inc., 4 pp, ill. Facilities for fabrication of ferrous or nonferrous metal powder parts. (73)

Stainless Steel. Armco Steel Corp., 4 pp, ill. Folder describes various booklets issued by Armco which are available free to the trade. (74)

Low-Alloy Steel. Bethlehem Steel Co., 66 pp, ill, No. 353. Properties and features of Mayari*R steel for use in applications requiring high strength and good wear and corrosion resistance. (75)

Iron and Steel Castings. Campbell, Wyant & Cannon Foundry Co., 24 pp, ill. Describes types of gray iron and steel castings. (76)

Stainless Steel Heads. G. O. Carlson, Inc. Various lists of typical uses and dies available. Price lists included. (77)

Steel Castings. Chicago Steel Foundry Co., 12 pp, ill. Physical properties and applications of Pyrasteel chromium-nickel-silicon heat-resisting alloys. Includes data for welding and casting. (78)

Specialty Steels. Crucible Steel Co. of America, 32 pp, ill, No. TM9. Information on cold rolled specialties, including stainless, alloy and carbon spring steels. (79)

Forged Metal Quality. Drop Forging Assn., 6 pp, ill. Detail of several hot working processes emphasizing improvements achieved in metal structure using these processes. (80)

Corrosion Resistant Castings. The Duraloy Co., 16 pp, ill, No. 3150-G. Describes facilities for manufacture of chromium-iron and chromium-nickel castings. Gives detailed properties of alloys and their uses. (81)

Conveyor Belt Castings. Electro-Alloys Div., American Brake Shoe Co., 6 pp, ill, No. T-241. Folder gives design details and applications for Thermalloy conveyor belts. Emphasizes resistance to "crank-shafting." (82)

Steel Castings. Farrell-Cheek Steel Co., 4 pp, ill, No. 40. Examples of the intricate electric furnace carbon and alloy steel castings produced by this company. (83)

Metal Powder Parts. Ferro Powdered Metals, Inc., 4 pp, ill. Numerous examples of powdered iron sintered structural parts. (84)

Lead Bearing Steel. Peter A. Frasse & Co., 3 pp, No. 12. Engineering memorandum on Ledloy-A which machines at speeds faster than steels used for common screw stocks. Compares analysis, mechanical properties and machinability. (85)

Stainless Tubing. Globe Steel Tube Co., 8 pp, ill, No. S-222. Uses of stainless steel tubing described, sizes and wall thicknesses of standard tolerances. (86)

Stampings. HPL Mfg. Co., 4 pp, ill, No. 718. Facilities for production of stampings in small lots. (87)

Double Headed Parts. John Hassall, Inc. Catalog shows numerous double headed parts, indicating applications and suggesting other applications of double heading operations. (88)

Machine Part Castings. Hunt-Spiller Mfg. Corp., 20 pp, ill. Gun iron castings of 100% pearlitic microstructure. (89)

Alloy Spring Steels. International Nickel Co., Inc., 18 pp, ill, No. EZ-93/29. Reprint includes charts, tables and photo-micrographs of alloy steels used for hot-formed springs. (90)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, ill. Describes facilities for producing good quality stampings to specifications, facts to be considered in ordering stampings and other data. (91)

Spring Steel. Lapham Hickey Co., 8 pp. Stock list of tempered and annealed spring steels. (92)

Seamless Steel Tubing. National Tube Div., U. S. Steel Co. Explains time-and cost-cutting fabricating applications of this company's Shelby seamless tubing. (93)

Stainless Steel Castings. The Ohio Steel Foundry Co., 4 pp, ill, No. 651-C. Compositions of Fabrite stainless steels for casting and illustrations of numerous corrosion resistant castings. (94)

Forgings. Pittsburgh Forgings Co., 8 pp, ill, No. 5201. Describes and illustrates the facilities of this company for producing drop, press and upset forgings. (95)

Metal Powder Machine Parts and Bearings. Powdercraft Corp., 4 pp, ill. Detailed specifications of a complete line of Powdercraft self-lubricating bearings and machine parts produced by powder metallurgy. (96)

Metal Containers. Pressed Steel Tank Co., 16 pp, ill. Tells how many industries have been helped in quality production at low cost by use of Hackney Metal containers and deep drawn component parts. (97)

Steel Hydraulic Tubing. Summerill Tubing Co., Div. Columbia Steel and Shafting Co., 8 pp, ill. Discusses tubing requirements, specifications for hydraulic applications, and advantages of steel seamless tubing. (98)

Permanent Magnets. Thomas & Skinner Steel Products Co., Inc., 12 pp, ill. Alnico 2, 3 and 5 standard magnets in stock. Bars, rings, channel bars, horseshoe shapes. Tables of magnetization curves, energy curves and physical properties. (99)

Steel Forgings. Titusville Forge Div., Struthers Wells Corp., 8 pp, ill. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (100)

Compression-Formed Tubing. Tube Reducing Corp., 8 pp, ill, No. R-3. Specifications, description and method of making steel compression-formed tubing included. (101)

Tool and Die Steels. Uddeholm Co. of America Inc., 28 pp. A handy stock list containing a complete line of tool and die steels and specialty strip steels produced by this company. (102)

Alloy Steel Castings. Unitcast Corp., 2 pp. Specifications, characteristics and uses of T-loy 42, alloy steel castings. (103)

Flexible Tubing. U. S. Flexible Tubing Co., 16 pp, ill. Description, applications and specifications of this company's flexible metal tubings, bellows for control units, and other metal parts. (104)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 69 and 70

Centrifugal Cast Parts. United States Pipe and Foundry Co., 12 pp, ill. Describes centrifugal castings process and advantages, and shows three applications improved by this method. (105)

Rigidized Metal Bonded Plywood. United States Plywood Corp., 8 pp, ill. Gives special features, advantages and wide variety of uses for Armoply, sheet metal bonded plywood. (106)

Ferro-Alloys and Metals. Vanadium Corp. of America, 24 pp, ill. "The Vancoram Review" presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (107)

Cold Formed Metal, Shapes and Tubes. Van Huffel Tube Corp. Folder of design sketches showing applications for coldformed metal shapes and tubing in many product uses. (108)

Pipe and Tubing. The Wallingford Steel Co., 8 pp, ill. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼-in. to 3-in. O.D. (109)

Steel Strip. Weirton Steel Co., 20 pp, ill. Characteristics of electrolytic zinc-coated sheets and strip, high-tensile steel and high carbon strip cold-rolled spring steel being manufactured by the company. (110)

Nonferrous Metals • Parts • Forms

Die Castings. The Accurate Die Casting Co., 24 pp, ill. Shows company's facilities for producing to order all types of zinc and aluminum die castings. Includes table of alloy properties. (111)

Die Castings. Admiral Die-Castings, Div. of Portable Electric Tools, Inc., 6 pp, ill. Folder describes company's die casting service. (112)

Precision Die Castings. Advance Tool and Die Casting Co., 3 pp, ill. Gives physical composition and average properties of zinc and aluminum alloys and illustrates some of the facilities for producing die castings. (113)

Wire Rod and Strip. Alloy Metal Wire Co., Inc., 4 pp, ill. Profusely illustrates the facilities of this company for producing wire rod and strip for a variety of industries. (114)

Aluminum Castings. Aluminum Alloys Corp., 14 pp, ill. Permanent mold aluminum casting with emphasis on molding and coring. (115)

Welding Aluminum. Aluminum Co. of America, 176 pp, ill. "Welding Alcoa Aluminum" discusses methods for welding aluminum. Stresses performance of aluminum welds and outlines methods of designing parts with welded joints. Tables give physical properties of Alcoa alloys, alloy compositions and strengths of welds. (116)

Aluminum Castings. Aluminum Industries Inc., 4 pp, ill, No. 20A. Describes this company's facilities offered to industrial plants that need aluminum castings for defense jobs. (117)

Machining Copper. American Brass Co., 32 pp, ill, No. B-3. Suggestions for machining copper, brass, bronze and nickel silver including tool rakes, clearances, cutting speeds and feeds. Tables give physical properties, constants and specifications of Anaconda metals and alloys. (118)

Prefinished Metal Sheet. American Nickeloid Co., 24 pp, ill. Properties and fabrication information on prefinished metal sheet. Includes examples and case histories of uses. (119)

MANUFACTURERS' LITERATURE

Bronze Bearings. Amplex Div., Chrysler Corp., 25 pp, ill, No. S-53. Lists more than 700 standard bearings, cores, bars and plates of heavy-duty, self-lubricating Oilite. Includes tables on bearing loads, dynamic capacities, clearances and machining characteristics. (120)

Aluminum Alloys. Apex Smelting Co., 8 pp, ill. Composition, physical, mechanical properties of the highly machinable Ternalloy aluminum alloys. (121)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of ferrous and nonferrous alloys recommended as most adaptable for this process. (122)

Aluminum Bronze Die Castings. Aurora Metal Co., 8 pp, ill. Description, advantages and sample products of firm's vacuum die casting process. Technical details of alloys used. (123)

Beryllium. Brush Beryllium Corp., 4 pp, ill. Uses of beryllium and its alloys and compounds. (124)

Titanium. Brush Laboratories Co., Div. of Clevite Corp., 4 pp, ill, No. 804. Complete data on titanium fabrication facilities. (125)

Cold Forming. Camcar Screw & Mfg. Corp., 8 pp, ill. Describes facilities for producing high strength small parts in high volume by cold forming. (126)

Die Cast Parts. Dollin Corp. Bulletin describes advantages of using this company's facilities for production of small zinc or aluminum precision cast parts. (127)

Magnesium Forms. Dow Chemical Co., Magnesium Div. Technical information on magnesium, its available forms and applications. (128)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (129)

Metal Stampings. Geometric Stamping Co., 4 pp, ill. Suggestions for cost savings through conversion from castings to stampings. (130)

Metal Stampings. Geuder, Paeschke & Frey Co., 12 pp, ill. Detailed description of this firm's metal fabricating, finishing and assembling facilities as a subcontractor for defense parts. (131)

Contact Rivets. Gibson Electric Co., 6 pp, ill, No. C-521. Description and specifications of a complete line of Gibson electrical contact rivets. (132)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of seamless braze and lock seam copper and brass tubing. (133)

High Temperature Alloys. Haynes Stellite Div. "Haynes Alloys for High Temperature Service" provides detailed tables and charts on their properties and heat treatment. (134)

Die Castings. Litemetal DiCast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (135)

Titanium. Mallory-Sharon Titanium Corp., 4 pp, ill. Properties of commercially pure unalloyed titanium produced by double melting. Recommended techniques for fabricating and forming titanium sheet. (136)

Bronze and Copper Castings. National Bearing Div., American Brake Shoe Co., 24 pp, ill. Cast bronze and copper products for general industry described. Charts of composition, analyses, properties and applicable specifications of National's copper, babbit, bronze and aluminum alloys. (137)

Precious Metal Wire. The J. M. Ney Co., 2 pp. Technical data on advantages of using Ney-Oro 6, precious metal wire for pivots in instrument bearings. (138)

Precision Castings. Ohio Precision Castings, Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium-copper plaster mold castings. (139)

Titanium and Its Alloys. Republic Steel Corp., 32 pp, ill, No. 588. A practical working manual presenting some basic and fairly well substantiated data on commercial quality titanium and its alloys. (140)

Aluminum Mill Products Design. Reynolds Metals Co., 12 pp, ill. Condensed information on Reynolds aluminum mill products. (141)

Strip and Sheet Brass. Scovill Mfg. Co., 4 pp, ill. Continuous-cast strip and sheet brasses and bronzes. (142)

Centrifugal Castings. Shenango-Penn Mold Co., No. 154. Describes centrifugal casting techniques for nonferrous alloy castings. Includes a detailed chart of comparative specifications, chemical properties and minimum physical properties of available alloys (143)

Aluminum Castings. Solon Foundry, Inc., 4 pp, ill. Description of company's plant and facilities for producing aluminum castings. (144)

Alloy Products. Specialloy, Inc., 8 pp, ill. Electric furnace alloys listed with nominal composition uses, properties forms. (145)

Spun Metal Parts. Spincraft Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (146)

Perforated Metals. Standard Stamping & Perforating Co., 4 pp, ill. Examples of pattern of perforated metal sheet. (147)

Light Metal Castings. Thompson Products Inc., 8 pp, ill. Describes a complete line of precision die castings for various industrial uses. (148)

Die Castings. Tri-State Die Casting Corp. New folder describes this company's facilities for production of aluminum and zinc die castings to order. (149)

Screw Machine Products. Westfield Metal Products Co., Inc., 4 pp, ill. Describes facilities for the production of a variety of machines, nuts and screw machine products. (150)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (151)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, ill. Announces the availability of large-size light alloy forgings particularly those of magnesium and 75-S aluminum. (152)

Mechanical Tubing. Youngstown Sheet & Tube Co., 4 pp, ill. Features size and wall thickness of a complete line of Yoloy electric weld mechanical tubing. (153)

Nonmetallic Materials • Parts • Forms

Industrial Textiles. The Albany Felt Co. Illustrated folder describes wide range of facilities for production of fabrics for industry. (154)

Molybdenum Disulfide as a Lubricant. The Alpha Corp., 4 pp, ill. Reprint discusses the properties and uses of pure molybdenum disulfide as a lubricant. (155)

Thermosetting Plastics. American Cynamid Co. Thirty success stories show outstanding sales advantages of using Cyanamid plastics, which are hard-wearing, hard-surfaced and hard-to-break. (156)

Plastisols. Arbonite Corp. Information file on plastisols and plastic protective coatings and linings. (157)

Gaskets, Packings, Etc. Auburn Mfg. Co., 3 pp, ill. Discusses the various products produced by this company, including gaskets, packings, washers, spacers, seals, shims and bushings. (158)

Wear Resistant Carbides. Carboloy Dept., General Electric Co., 12 pp, ill. No. WR-107. Latest information on the use of cementing carbides in wear-proofing pulverizing equipment used in applications ranging from processing alfalfa to pulverizing powdered metal. (159)

Silicon Carbide. Carborundum Co., 52 pp. Extensive brochure discussing the properties of silicon carbide in relation to its use as a refractory in heating elements, in electrical resistors, as catalyst carriers and as a porous media, as well as to its abrasive applications. (160)

Plastic Pipe. Carlon Products Corp., 4 pp, ill. Contains factual informative answers to most frequently asked questions about carbon flexible plastic pipe and carbon rigid pipe. (161)

Plastic Sheets. Cast Optics Corp., 12 pp. Technical properties and fabrication data of clear cast thermoset "Cocor" sheet. (162)

Coated Fabrics. The Connecticut Hard Rubber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated glass fabrics. (163)

High Strength Plastics. Continental-Diamond Fibre Co., No. GF-50. Properties, descriptions and applications of five of this company's high strength plastics. (164)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Gives dimensions of molded and extruded rubber with cross sectional illustrations. Also condensed SAE and ASTM specification chart. (165)

Glass. Corning Glass Works, Dept. MM-6, 12 pp. Gives reasons why glass is increasingly important in product design. (166)

Plastic. Crane Packing Co., 12 pp, ill, No. T-103. Complete data on Chemlon packings and gaskets fabricated from the new tetrafluoroethylene resin, Teflon. (167)

Industrial Textile Fibers. E. I. du Pont de Nemours & Co., Inc., Textile Fibers Dept., 20 pp. Consideration of synthetic fibers as industrial materials. Includes rayon, acetate, nylon, orlon, dacron, teflon, fibers. (168)

Glass-Silicone Laminate. The Formica Co., 4 pp, ill. Glass-Silicone laminate for use in sealed, dry-type transformers. (169)

Plastics Parts. Franklin Plastics Div. of Robinson Industries, Inc., 6 pp, ill. Illustrates variety of plastics products and discusses this company's injection molding facilities. (170)

Plastic Products. General American Transportation Corp., Plastics Div., 10 pp, ill. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of this company's molded plastics. (171)

Rubber-to-Metal Adhesive. General Tire & Rubber Co., Chemical Div., 8 pp, ill, No. 4016. Complete data on Kalabond rubber-to-metal adhesive for non-corrosive solvent-resistant bonding. (172)

Polystyrene Sheet. Gilman Bros. Co., 4 pp,

MANUFACTURERS' LITERATURE

ill. High impact polystyrene sheet for vacuum forming. Has five times the strength of general-purpose sheet. (173)

Reinforced Laminates. Glastic Corp., 8 pp, ill. Description, properties and performance comparison of plastics, polyesters reinforced with Fibreglas for heavy duty eletrical insulation. (174)

Plastics. Heil Process Equipment Corp., 4 pp, ill, Vol. 4, No. 1. Suggests applications for Rigidon, a glass-reinforced plastic; Rigidin, a rigid vinyl plastic; and Rigidene, a polyethylene plastic. (175)

Fluorocarbon Plastics. M. W. Kellogg Co., 16 pp, ill. Index of processors and converters, manufactured items and services connected with the production of Kel-F parts and forms. (176)

Acid Proof Ceramic Pipe. Maurice A. Knight, 12 pp, ill. Specifications and description of this company's ceramic pipe fittings, said to be almost universally acid proof. (177)

Foam Polystyrene. Koppers Co., Inc., 10 pp, No. C-4-200-T. Describes expandable polystyrene beads and polystyrene foam. Includes physical and chemical property listings, suggested applications, molding data and instructions for use of adhesives with the material. (178)

Vibration Control Materials. Lord Manufacturing Co., 12 pp, ill. Stock list of vibration-control shock mounts and couplings. (179)

Plastic Molding. P. R. Mallory Plastics, Inc., 4 pp, ill. Complete production facilities for large scale production of custom-molded parts from design to finishing and assembly. (180)

Reinforced Wood. Met-L-Wood Corp., 15 pp, ill, No. 521. Describes combined wood and metal sheets, providing light weight and high strength. (181)

Nylon Parts. Nylon Molded Products Corp., 4 pp, ill. A simple "rule-of-thumb" method for calculating the material cost of a nylon part. (182)

Molded Rubber. Parker Rubber Products Div., Parker Appliance Co., 4 pp, ill, No. 5201A1. Custom molding facilities for rubber parts. (183)

Plastics. Regal Plastic Co., 4 pp, ill. Facilities for the fabrication of plastic products. (184)

Rigid Polyvinyl Chloride. Seiberling Rubber Co., 11 pp, ill. Physical, chemical, electrical and thermal properties of Seilon, an unplasticized polyvinyl chloride compounded from Geon resins. Includes complete technical data for forming. (185)

Plastics. Sillcocks-Miller Co., 4 pp, ill. Applications of plastics as an alternate to hard-to-get metals (186)

Cellular Rubber. The Sponge Rubber Products Co., 20 pp, ill. Properties of specifications for, and test data on this firm's cellular rubber materials. (187)

Ceramic Laboratory Ware. The Thermal Syndicate Ltd. Technical descriptions, specifications and prices of Vitreosil ware, said to be superior to porcelain in some uses. (188)

High Temperature Insulation. H. I. Thompson Co., 34 pp, ill. Detailed technical data on Refrasil, giving case histories on performance characteristics as a high temperature insulator. (189)

Plastisol. United Chromium Inc., 4 pp, ill. Physical, chemical properties of Unichrome plastisol compounds used for coating, casting or molding. (190)

Synthetic Rubber Sheet and Roll Goods. Acadia Div., Western Felt Works, 2 pp, samples. Ten samples clipped to chart of physical specifications. Durometer, tensile and elongation characteristics. (191)

Laminated Plastics. Westinghouse Electric Corp., 50 pp. Catalog on industrial Micarta covering all grades and forms in which Micarta is supplied, and the chemical, mechanical and electrical properties of each. Machining data provides fabrication information. (192)

Sealing Design. Franklin C. Wolfe Co., Inc., 4 pp, ill. Describes facilities and products for sealing bolts, studs, rivets, flanges, etc. (193)

Finishes • Cleaning and Finishing

Wet Blasting Machine. American Wheelabrator & Equipment Corp., 6 pp, ill. No. 33. Complete data on the Model 64 Liquamatte wet blasting machine for handling individual pieces or loads weighing up to 3500 lb. (194)

Buffing Compound. Apothecaries Hall Co., 2 pp, No. B-1. Information on grease-type buffing bars for use on polished surfaces or surfaces with uniform roughness, *e. g.* stamped, drawn or rolled. (195)

Protective Coatings. Ceilcote Co., 8 pp, ill, No. C-150. Gives base formulations, chemical properties and adhesion characteristics of seven standard organic coatings. Includes simplified chart for selecting coatings, surface treatment, processes, etc. (196)

Hard Facing. Cleveland Hard Facing Inc., 4 pp, ill. Service for hard facing parts subject to intense wear conditions. (197)

Buffs and Polishing Wheels. F. L. & J. C. Codman Co., 24 pp, ill, No. 52. Presents a complete line of conventional and non-fray ventilated buffs and polishing wheels. Includes specifications. (198)

Spray Painting. Conforming Matrix Corp., 5 pp, ill. Gives description, uses and advantages of this firm's spraying masks, mask washing machine, and spray painting equipment. (199)

Metal Washers. Despatch Oven Co., 12 pp, ill, No. 68. Presents complete line of metal washers or metal cleaning and treating applications. (200)

Industrial Cleaning. Du Bois Co. Metal cleaning chart with folder on three-stage spray cleaning and a spray booth maintenance check chart. (201)

Industrial Finishes. Glidden Co., 11 pp, ill. Properties and advantages of Nu-Pon primer and enamels. (202)

Finishing and Deburring Processes. The Grav-I-Flow Corp., 20 pp, ill. Catalog of tumbling deburring equipment and accessories including price lists and abrasive compounds available. (203)

Mechanical Finishing. Mecha-Finish Corp., 4 pp, ill. Low cost deburring and finishing abrasives chips. (204)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish, said to resist heat of 500 F without discoloration. (205)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 69 and 70

Metal Cleaner. Mitchell-Bradford Chemical Co., 1 p. Description of Magiclene #2 cleaners and degreasers. (206)

Aluminum-Chromium Paint. Monroe Co., Inc., 4 pp, ill, No. C-54-8. Includes detailed application data on Monco-Alochrom, an aluminum-chromium paint for exterior and interior surfaces of all kinds. (207)

Micropolishing. The Murray-Way Corp. Engineering specifications and auxiliary equipment needed for micropolishing. (208)

Metal Cleaners. Northwest Chemical Co., 4 pp. Chart for selecting proper cleaners for use prior to plating or organic finishing. (209)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Aluminum Coating. Royston Laboratories Inc., 2 pp, ill. Discusses Royalac Aluminum, a high quality industrial aluminum coating with the newly developed nonspattering feature. (210)

Corrosion Resistant Coating. Specialty Coatings Inc., Div. of Thompson & Co., 6 pp, ill. Examples of how Vinsynite Pretreatment was used in finishing six different types of metal products for good paint adhesion and corrosion resistance. (211)

Electroplated Rhodium. Technic Inc., 1 p. Technical data sheet on electroplated rhodium also announces the availability of heavy rhodium plated deposits. (212)

Zirconium Glazes for Ceramics. The Titanium Alloy Mfg. Div., 30 pp. Description, uses and properties of TAM zirconium glaze opacifiers. (213)

Wet and Dry Tumbling. Tumb-L-Matic, Inc., No. PC-52. Describes five processes for finishing metal and plastic parts by tumbling parts with abrasive materials in rotating barrels. (214)

Emulsion Cleaners. Turco Products, Inc., 10 pp, ill, 106 Series Technical Sheets. Charts, uses, methods of applications, safety precautions, etc., for seven types of emulsion cleaners. (215)

Hard Facing Alloy. Wall Colmonoy Corp., 3 pp, No. 10. Data sheets on Walmang austenitic nickel manganese steel welding electrode possessing general characteristics of 12% manganese steel. (216)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (217)

Heat Treating • Heating

Cyclic Annealing. Ajax Electric Co., Inc., 4 pp, ill, No. 121. Explains cyclic annealing process and its advantages over regular annealing methods. (218)

Induction Furnaces. Ajax Electrothermic Corp., 8 pp, ill, No. 27A. Advantages and applications of, and equipment for induction heating and melting. Includes selector chart for induction heating and melting. (219)

Induction Furnaces. Ajax Engineering Corp. Information on Ajax-Tama-Wyatt induction furnaces for melting metals with accurate temperature control and freedom from contamination. (220)

Heat Treating Furnaces. A. D. Alpine Inc., 4 pp, ill. Gives features and specifications of six Contro-Therm heat treating furnaces for all types of heat treating, soldering and brazing. (221)

MANUFACTURERS' LITERATURE

Industrial Furnaces. Gas Machinery Co., 4 pp, ill. No. A-100. Describes a complete line of Gasmaco fuel-fired, high temperature furnaces for all types of heat treatment. (222)

Shaker Hearth Furnace. Hevi Duty Electrical Co., 4 pp, ill, No. HD-850. Horizontal, split tube type furnace for heat treating operations requiring temperatures to 1900 F. (223)

Tube Elements for High Temperature Furnaces. Kanthal Corp., 9 pp. Applications, construction and specifications of Kanthal tube elements for high temperature furnaces used in ceramics, chemical, glass and metal industries. (224)

Gas-Fired Vertical Radiant Tube Furnaces. Lindberg Engineering Co., 44 pp, ill, No. 241. Design and application features of Lindberg carbonitriding furnaces that can be used for carbonitriding as well as carburizing, annealing, carbon restoration and other hardening jobs. (225)

Hole Quencher. Palmer Mfg. Co., 4 pp, ill. Features advantages of using the I. D. Hole-Quencher for case hardening holes seven times faster. (226)

Electric Furnaces. Pereny Equipment Co., 3 pp, ill, No. 4A. Booklet tells advantages and illustrates typical group of furnaces and kilns and their uses. (227)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (228)

Appliance Insulation. Owens-Corning Fiberglas Corp., 8 pp, ill. Analysis of various products utilizing Fiberglas for temperature or sound insulation. (229)

Portable Base Convector Furnaces. Lee Wilson Engineering Co., Inc., 19 pp, ill. Features and advantages of the new portable base-single stack furnace. (230)

Welding • Joining

Rubber-to-Metal Bonding. Acushnet Process Co., 8 pp, ill, No. 51-A. Supplement A to the Acushnet rubber data handbook gives more detailed information concerning the rubber-to-metal adhesion process. (231)

Silver Brazing. American Platinum Works, 48 pp, ill. Reference manual on silver brazing discusses low temperature brazing, brazing alloys, design considerations and other topics. (232)

Fastening Pins. C. E. M. Co., 4 pp, ill. Advantages and examples of how Spirol Pins overcome the inherent shortcomings of fastening pins due to their spiral cross-section. (233)

Welding Cost Calculator. Champion Rivet Co., slide indicator. Shows the cost for welding materials using various types of fillets and joints, and estimates the various factors affecting the cost. (234)

Solders and Fluxes. Division Lead Co., 2 pp, No. PF132. Descriptions of a variety of Divco transistor solders and fluxes produced by this company. (235)

Explosive Rivets. E. I. du Pont de Nemours & Co., Inc., Explosives Dept., 32 pp, ill, No. A-2281. Complete data on two types of explosive rivets—high-speed industrial explosive rivets and aircraft explosive rivets. Specifications and installation procedures are included. (236)

Solder Paint. Fluxolder Products Co., 22 pp, ill. Advantages, operations and uses of Fluxolder solder paint. (237)

Rivet-Type Fasteners. B. F. Goodrich Co., Rivnut Div. Cardboard "demonstrator" illustrates working principle of Rivnuts, their construction and applications. (238)

Silver Brazing Alloys. Handy & Harman, 24 pp, ill, No. 20. Information on Easy-Flo and Sil-Fos low temperature silver brazing alloys, and valuable data on brazing methods. (239)

Fasteners. H. M. Harper Co., 8 pp, ill, Vol. 19, No. 2. Various case histories of the applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (240)

A.C. Welder. The Lincoln Electric Co., 2 pp, ill. Specifications of new low cost A.C. welders. (241)

Stainless Steel Electrodes. The McKay Co., 48 pp. Data on arc welding of stainless steels, giving specific uses of alloying elements and specifications of each type of McKay stainless steel electrode. (242)

Vulcanized Bonding. Marbon Corp., 23 pp, ill. Two-coat adhesive system for obtaining high-strength rubber to metal vulcanized bonds with natural rubber, GR-S compounds and certain types of Buna N stocks. (243)

Welded Steel Tubing. Michigan Steel Tube Products Co., 8 pp, ill. Properties and ranges of resistance-welded steel tubing, mechanical tubing, cold drawn tubing and fabricated parts. (244)

Fasteners. Milford Rivet & Machine Co., 12 pp, ill, No. MM52. Detailed information on an integrated service of fastener research, design, engineering and production collaboration. (245)

Welding Studs. Nelson Stud Welding, Div. of Gregory Industries, Inc. Wall Chart No. 1. Dimensions and applications of standard MG studs. 12 pp booklet also available. (246)

Fasteners. Pheoll Mfg. Co., 4 pp, ill. Shows company's stock of various types of screws, bolts, and nuts for joining and assembling. (247)

Industrial Tape. Polyken Products, Div. of Kendall Co., 13 pp. Pressure sensitive tape dictionary. Tapes of all manufacturers described and listed by number. (248)

Nut Clip Fastener. Prestole Corp., 2 pp, ill, No. 751-A. Engineering and application data of a new heavy-duty nut clip fastener that rapidly assembles heavier gage sheet metal. (249)

Fasteners. Simmons Fastener Corp. Literature describes fasteners especially designed for use in construction where easy demountability is required. (250)

Copper-Aluminum Welding. Taylor Winfield Corp., 4 pp, ill. Description of the technique of resistant flash-butt welding for joining copper to aluminum. (251)

Locknut. Thompson-Bremer & Co., 6 pp, ill. Brochure stresses spin-down feature for manual control to within one-quarter turn of fully locked position. (252)

Nut Retainers. Tinnerman Products, Inc., 8 pp, ill, No. 245-3. Specifications and descriptions of Speed Grip nut retainers offering a sure method of keeping nuts secure. (253)

Cold Formed Fasteners. Townsend Co., 4 pp, ill, No. TL89. Discusses features, advantages and design requirements for fabricating cold headed parts and fasteners. (254)

Forming • Casting • Molding • Machining

Die Molding Material. Chemical Development Corp., 4 pp, ill. Describes a steel powder-and-plastic molding material, used for making jigs and forming dies. (255)

Presses. Denison Engineering Co., 16 pp, ill. Features the installation and uses of the Denison hydraulic Multipress. (256)

Shell Molding. Durez Plastics and Chemicals, Inc., 26 pp. Durez guide to shell molding. Discusses the methods, material, equipment used in shell molding. (257)

Springtites and Sems. Eaton Mfg. Co., 4 pp, ill, folder C-49a. Thread cutting and self tapping springtites and sems. Dimensions. (258)

Semi-Automatic Presses. The Hydraulic Press Mfg. Co., 4 pp, ill, No. 5107. Gives description and specifications of H-P-M automatic compression and molding presses for reinforced plastics molding. (259)

Die Casting Machines. Lester-Phoenix, Inc. Folder gives description, features and specifications of this company's die casting machines and injection molding machines. (260)

Tungsten Carbide Compacting Tools. National Carbide Die Co., 4 pp, ill. Discusses various tungsten carbide compacting tools as they are applied to powdered metallurgy. (261)

Inspection • Testing • Control

Laboratory Microscopes. Bausch & Lomb Optical Co., 24 pp, ill, No. D-185. Description and specifications of various microscopes for such uses as metallurgical microanalysis. (262)

Wrattan Filters for Technical Use. Eastman Kodak Co., 343 State St., Rochester 4, N. Y., 78 pp, price 75c. "Kodak Wrattan Filters for Scientific and Technical Use" lists over 100 filters having applications in black-and-white and color photography, and discusses forms and types of filters, their standard uses and care. Write direct to Eastman.

Mass Spectrometer. General Electric Co., 12 pp, ill, No. GEC-587A. Describes the uses of the mass spectrometer for chemical analysis, and contains photographs and diagrams of the equipment and its parts. (263)

Industrial X-ray Units. Keleket X-Ray Corp., 8 pp, ill, No. 212. Profusely illustrates various industrial x-ray units for non-destructive testing. (264)

Testing Calibration. Morehouse Machine Co., 2 pp, ill. Equipment for calibrating mechanical testing equipment. Specifications and performance data given. (265)

Test Cabinets. Refrigeration Systems, Inc., Hudson Bay Div., 8 pp, ill. Illustration and descriptions of various types of test cabinets providing refrigeration, humidity and vibratory environments. Specification data given. (266)

Torsion Tester. American Machine & Metals, Inc., Riehle Testing Machines Div., 8 pp, ill. Machines for twist-testing components, assemblies, sample stock and wire. (267)

Thermocouples. Thermo Electric Co., Inc., No. G. Shows large variety of wire-type thermocouple assemblies available in many sizes. (268)

Impact Tester. U. S. Testing Co., Inc., 2 pp, ill. Includes history, description and use of the SPI low temperature impact tester. (269)

General

Industrial Chilling Equipment. Sub-Zero Products Mfg. Div., Deep Freeze Distributing Corp., 8 pp, ill. Specifications and uses of industrial chilling machines for shrinking, testing and treating of metals. (270)

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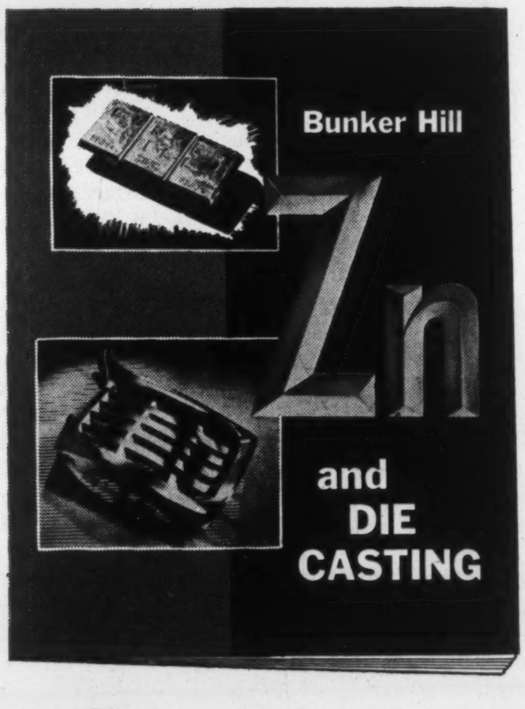

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One point of view

Not censorship, but . . .

Normally this department steers clear of politics, but from time to time certain events transpire that move us to make some comment. A recent announcement from the Department of Commerce has caused us to be so moved. Before going into details, perhaps it might be well to state that as far as we can see, the greatest difference in the major political parties at any given time is that one is in power and the other is out.

The announcement in question told of the formation of an Office of Strategic Information in the Department of Commerce. This office, according to the news release, "will work with the business community in voluntary efforts to prevent unclassified strategic data from being made available to those foreign nations which might use such data in a manner harmful to the defense interest of the United States."

The release states further: "Such watchfulness would not take the form of censorship. It would instead be a matter of exercising intelligent, reasonable precaution to make sure that in the necessary free exchange of scientific information we do not provide nations whose interests are inimical to our own with material which they could some day use against us."

These goals sound fine, but we seriously doubt their practicability. The same type of scheme was tried in the early post war period and failed miserably. The only tangible result, as we see it, was to further stifle the free exchange of information.

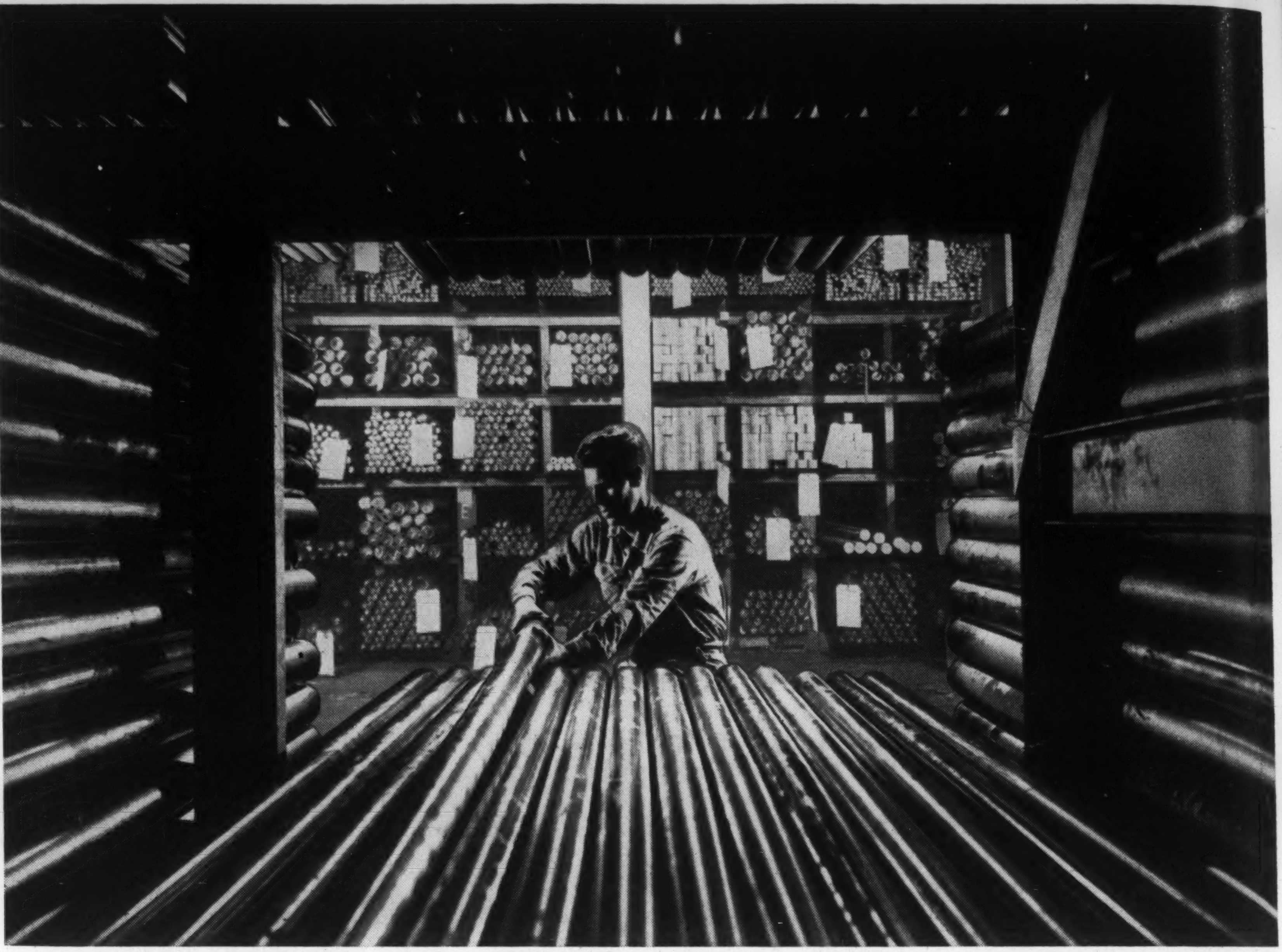
Further, we can see no need for such a group. If scientific work is such that it has military value, it should not be in the unclassified category. On the other hand, if it is the type of information that could be used by industry in general, but does have some military value, it would seem that the advantages of widespread dissemination of such information would far outweigh any potential disadvantages.

Perhaps we are building up groundless fears, but our past experience has taught us that in the matter of release of technical information, those concerned with making vital decisions are likely to take the line of least resistance. If there is the slightest doubt about the strategic value of any information the tendency will be to say "No" to a request of its release.

We are fully aware of the need for national security, but at the same time we don't feel that we will ever achieve peace if we constantly act as though a spy were lurking in our every shadow. Even the Atomic Energy Commission, once the most security conscious agency of the government, has recently taken steps to permit the release of much of the vital technical information buried in its files. Why now do we have to reverse this trend in less sensitive areas?

Our final gripe against the Office of Strategic Information is that in making up the personnel of the group to administer it there is no representative of the business and technical press, the one group that will be most affected by the actions of the new bureau.

T. C. Du Mond



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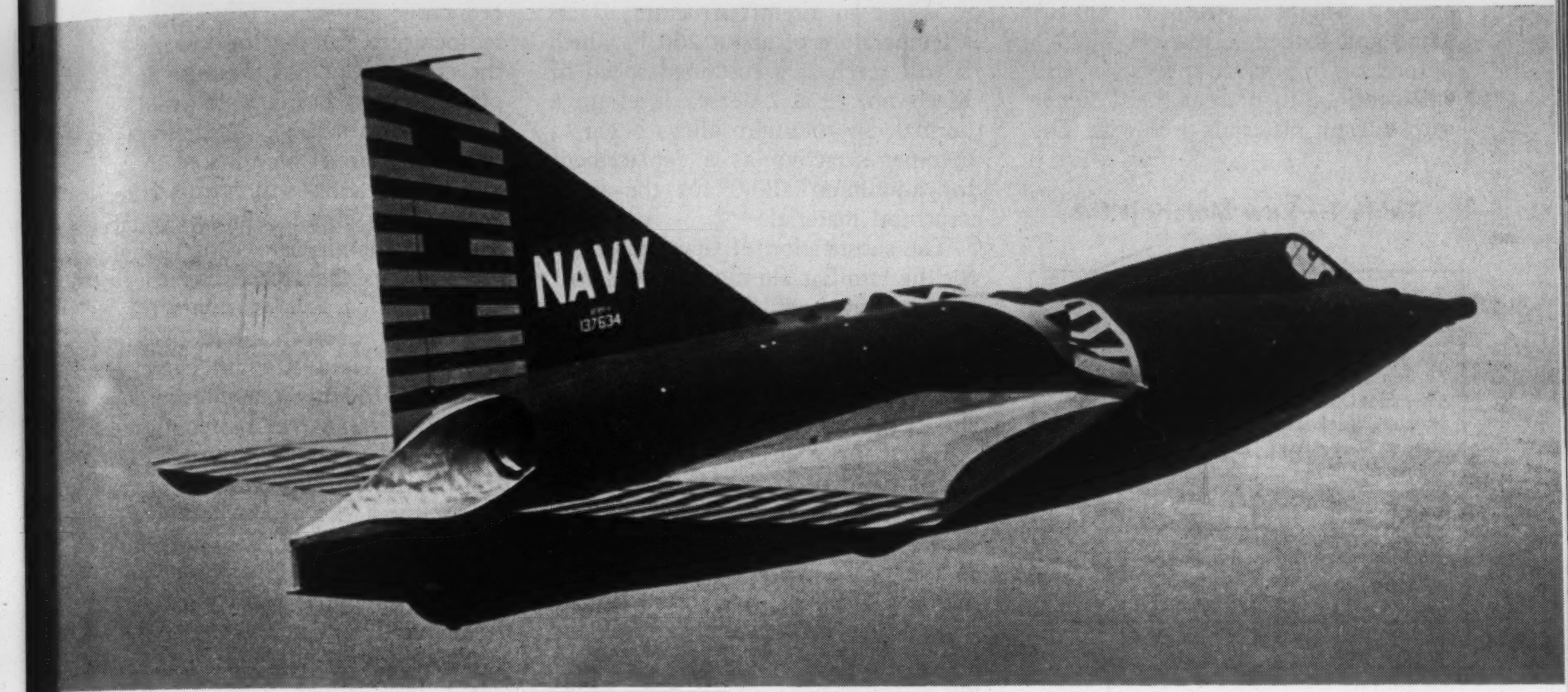
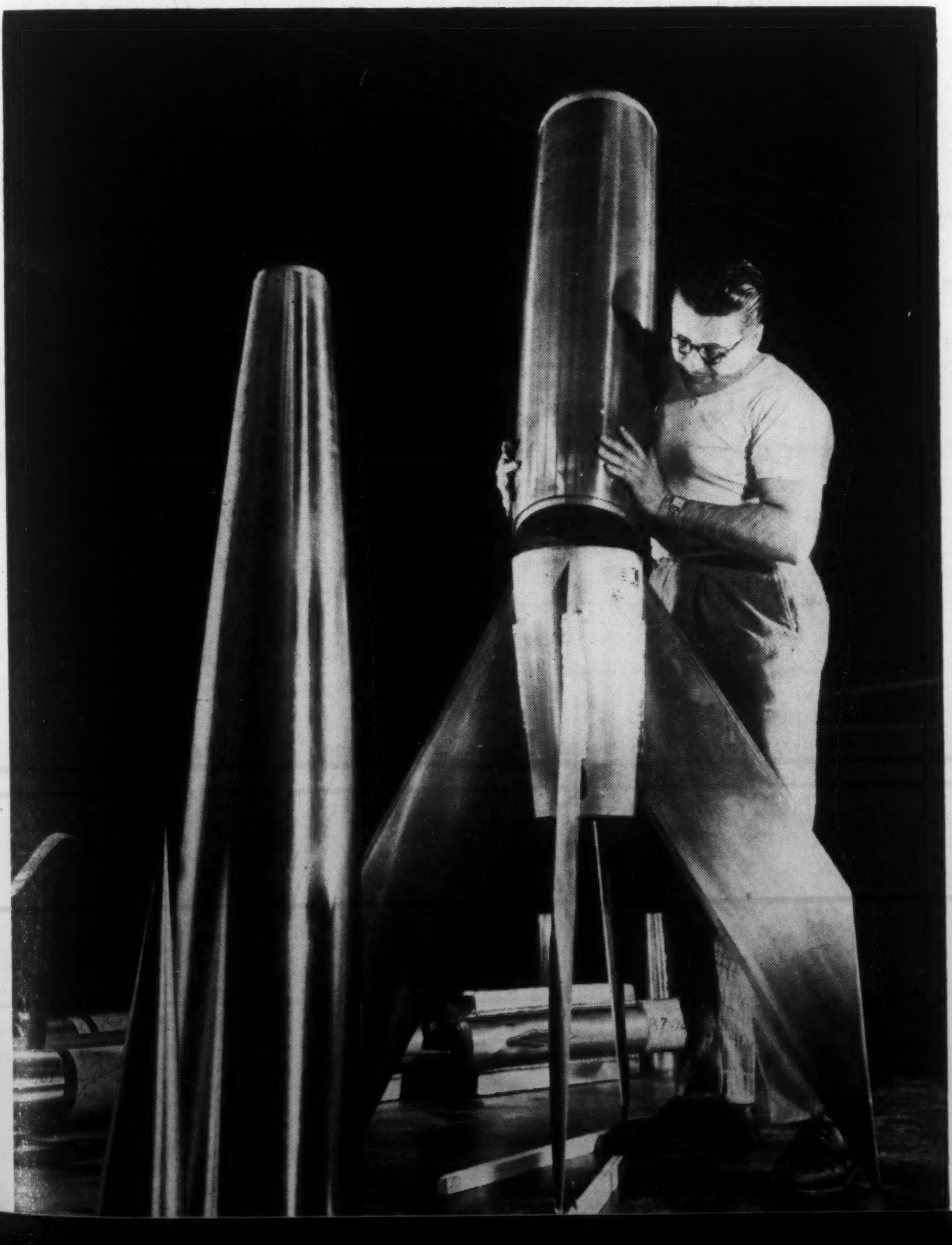
Selecting Metals for Supersonic Aircraft and Guided Missiles





At supersonic speeds, aerodynamic heating becomes a critical problem which the engineer must solve by proper materials selection and design.

by SPENCER L. SHAW,
Design Specialist,
Douglas Aircraft Co., Inc.

● THE SELECTION OF the best material for use in aircraft construction involves primarily the problem of finding the lightest material which will satisfactorily perform the required function. In no other field of engineering is this one principle adhered to so rigidly. The obvious reason for this is that every unnecessary pound used in the structure subtracts directly from the useful load (difference in weight between empty airplane and loaded airplane).

Increase in aircraft speeds has and will continue to present the designer with difficult materials problems. The increase in speed has necessitated thinner airfoil sections which are inherently heavier than thicker sections. So, in order to keep the weight down, the designer has had to evolve and perfect the methods of construction and has had to avail himself of all the advances in the field of metallurgy. Recently, a new problem has arisen to plague the designer because of the increase in speed. This problem is the decrease in material strength due to the elevated temperatures in the structure resulting from adiabatic compression of the air at high airplane velocities. Therefore, if we are to continue to keep the useful load up to its present proportions, it will become increasingly important that the metallurgist improve the properties of the construction materials, especially at elevated temperatures, and that the designer select the proper material.

Table 1—Raw Materials for an Aircraft

Material	Lb	%
Iron Castings	49	.21
Carbon Steel	38	.16
Alloy Steel	4996	21.48
Stainless Steel	1305	5.62
Copper Base Alloys	295	1.27
Aluminum Alloys	16386	70.60
Magnesium Alloys	84	.36
Lead	59	.25
Monel	11	.05
Totals	23223	100.00

Materials Problems at Supersonic Speeds

Fig 1 shows how various structural materials compare on a strength-density ratio for various temperatures. This figure is based on the ultimate tensile strengths of the various materials. Since much of the structure of an aircraft is designed by the stability properties under compressive stress, the aluminum alloys compare much more favorably to titanium alloys than shown in Fig 1 in the lower temperature range—due to the lower density of the aluminum alloys. This allows the use of thicker sections.

When an aircraft structure attains a temperature of about 200 F, which it will reach at a sustained speed of Mach no. = 1.2 at sea level on a normal day, titanium alloys begin to become attractive as a replacement for aluminum alloys for the main structural material.

The substitution of titanium alloys for the familiar aluminum alloys will bring many new problems both to the designer and to the fabricator. Titanium is very difficult to machine due to a tendency to gall and smear, and due to the high temperature at the tool tip. Special cooling techniques are being developed and the proper tool shapes and best cutting speeds are rapidly being determined so the problem of machinability of titanium is being overcome. But it will always be more of a problem than it is with aluminum. The forming characteristics of titanium alloy sheet have been compared with those of three quarter hard 18:8 stainless steel. The only feasible method of forming titanium alloy sheet appears to be hot forming. (See MATERIALS & METHODS, Sept., 1954, p. 98). Methods of hot forming titanium alloy sheet have been developed, but it appears that the designer will have to learn new limitations in regard to bend radii, depth of beads, etc.

Table 2—Number of Materials Specifications

	Alloy Steel	Stainless Steel	Aluminum	Magnesium
Bar	12	6	3	—
Sheet	1	8	10	1
Plate	3	—	4	—
Forgings	5	1	3	—
Castings	—	—	3	1
Extrusions	—	—	8	1
Tubing	3	4	3	—
Totals	24	19	34	3

The upper limit of the use of the presently available titanium alloys at sustained temperature is about 700 F. This limit is imposed, not by the reduction in static properties with temperature, but by the lowering of the creep properties. Because an airplane must be designed to avoid permanent deformation, a criterion covering creep must be adhered to, and at elevated temperatures this criterion becomes more difficult to meet than that for ultimate static strength. Fig 2 shows the creep properties of C-110M alloy. It is significant to note that the creep curve does not follow the yield strength curve. In the intermediate temperature range, stresses above the yield strength must be imposed upon the material in order to produce appreciable creep; at temperatures near room temperature and at tempeatures above approximately 700 F, creep is observed at stresses below the yield strength of the material.

Above 700 F, stainless steel and cobalt base alloys seem to be the most promising materials. Unfortunately, at about this temperature, the unstabilized 18:8 stainless steels begin to undergo a metallurgical change which makes them unsuitable for use at sustained temperatures. This leaves only stabilized stainless and cobalt base alloys. The upper limit for these materials will be about 1400 F due to the rapid decrease in creep properties at this temperature. This upper range takes us to about Mach no. = 4.0 at sea level and Mach no. = 10.0 at about 185,000-ft altitude.

The usable flight spectra of the various metals discussed are shown graphically in Fig 3. This figure shows the stabilized temperatures at speeds to Mach no. = 10.0 and up to an altitude of 200,000 ft. The calculations assumed a recovery factor of 0.9, an emissivity factor of 1.0 and no solar heat. At the stagnation point near the nose of airfoil sections the temperatures will be somewhat hotter than shown and special methods of construction might be necessary in this region.

Short Time Conditions

The flight spectra, Fig 3, are based upon flight speeds sustained long enough for the structure temperature to become stabilized. Since highest speeds encountered by an aircraft will be those in a dive and since a dive necessarily must have a limited duration, the aerodynamic heating of the

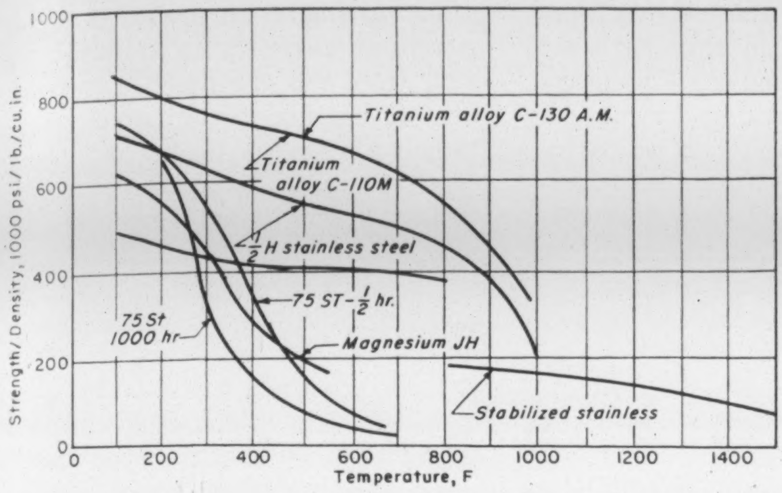


Fig 1—How various structural metals compare on a strength-density ratio at elevated temperatures.

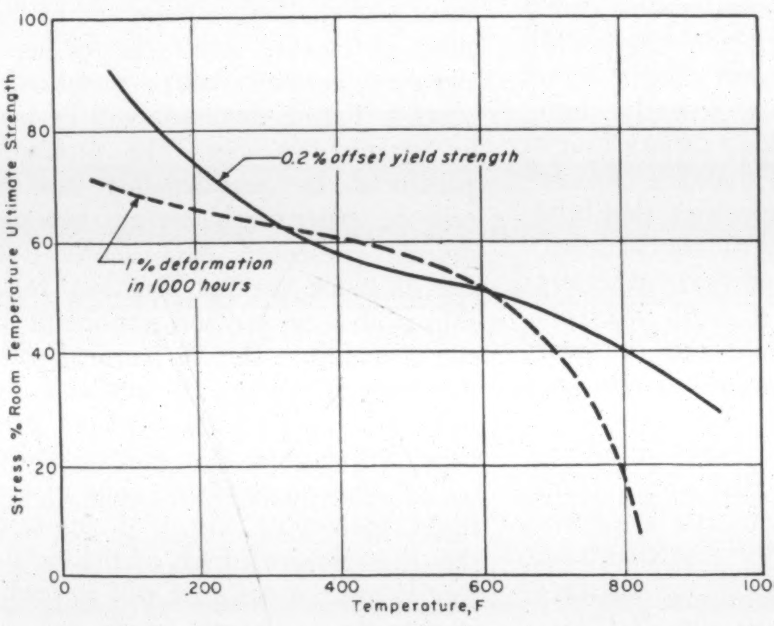


Fig 2—Creep properties vs temperature of C-110M titanium alloy sheet.

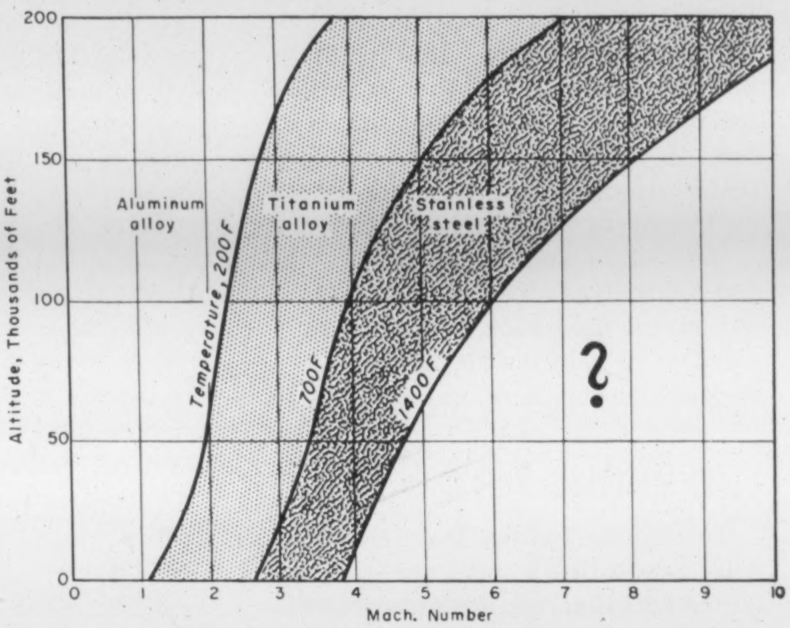


Fig 3—Flight spectra of metals shows maximum speed levels of aircraft produced with skins of aluminum, titanium and stainless steel.

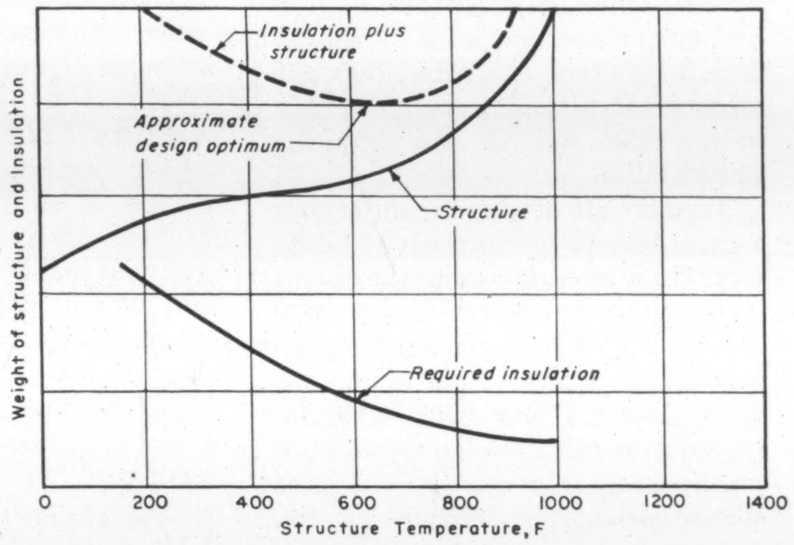


Fig 4—Design study illustrates optimum combination of insulation and titanium alloy for the skin of a theoretical supersonic aircraft or missile.

structure during a dive presents a special problem. Due to the heat capacity of the structure, the temperature attained by the structure during a dive will generally be lower than that shown in Fig 3 for a specified speed and altitude.

However, the transient heating of structure introduces another problem: the large temperature gradients in the structure. The outside structure, exposed directly to the airstream and being relatively thin, will tend to heat quickly and approach the stabilized temperature, while the interior ribs, stiffeners, and spars will lag behind and remain considerably cooler. If all members are of the same material, differential expansion will occur and set up very high thermal stresses.

One attack on this problem would be to use materials with different coefficients of thermal expansion for the various members. For instance, titanium could be used for the outside skin while aluminum alloys with a thermal expansion coefficient 2.6 times as great as that of titanium could be used for the interior members.

One approach to provide for high speeds during a dive of an airplane or the final plunge of a long range ballistic missile, would be to use an insulating material outside of the structure. The designer would have to balance the weight saved by the increased allowables against the weight of the insulating material. Fig 4 shows the results of a weight study of a theoretical vehicle which would attain a temperature of 1400 F with an uninsulated skin of titanium alloy 0.064 in. thick during a dive. The study indicated that the most suitable construction material would be titanium alloy covered with sufficient insulation to hold the temperature down to the 600-700 F range.

Another feasible manner of keeping the structure temperature down to acceptable limit during a dive is to make use of the high latent heat of evaporation of water. This can be accomplished by two methods. One method merely forces the water through a porous outer skin where the water evaporates. Another method is to evaporate and then superheat the vapor in the interior of the structure. A design study concerning the feasibility of cooling the nose section of a wing by this method showed it to be very promising. As was the case with insulation, a careful study will reveal the proper operating temperature to achieve the lightest combination of structure and water.

Other Materials Problems

To find the lightest material which will satisfactorily perform the required function, qualifications besides strength must be considered. These include stiffness, fatigue strength, availability, corrosion-resistance, wear resistance, formability, machinability, and toughness. In some special applications, other characteristics, such as magnetic properties, must be considered. In contrast to its importance in other fields of engineering, the cost of the basic material is a secondary consideration.

To meet all of these requirements a great variety of materials is necessary. On a recently designed airplane with a gross weight of about 18,000 lb, a bill of material summary showed the actual weight of the airplane structure was about 8400 lb. In order to fabricate the 8400 lb, it was necessary to procure 23,223 lb of raw material. The amount of raw material broken down into nine basic groups is shown in the table. Another table shows the number of specifications necessary to purchase some of these groups. This airplane, it should be noted, was not seriously affected by aerodynamic heating and, consequently, no use was made of any titanium, titanium alloys, or high temperature alloy steels. Nevertheless, the designers needed eighty specifications to cover the main structural metals.

There is a definite trend towards the use of large single piece aircraft components. The desire for increased structural efficiency and lower fabrication costs has brought this about. Some single pieces of structure are now being fabricated which would have required literally hundreds of separate pieces and thousands of rivets if constructed in the conventional manner.

The use of large structural components had to await the arrival of large homogeneous plates, forging billets, and extrusions. These materials are now available, but machines for fabricating the finished parts are still limited in number. The heavy press program sponsored by the Air Force is just beginning to be useful for supplying heavy forgings and extrusions. However, considerable experience has been accumulated by several aircraft companies in the fabrication of integral wing and control surface skins by the machine-sculptured plate method. This method has proven quite satisfactory, and the main caution in its use is to make sure that sufficient machines will be available to meet the production rate contemplated.

Alloy steels have always held a pre-eminent place in the design of aircraft landing gears. Steel was used in spite of the lower strength-weight ratio as compared to some aluminum alloys because of other desirable characteristics. These include toughness, wear resistance, and high unit strength. Until very recently, heat treatment to produce extra high strengths had been avoided because of the long held impression that brittleness is an inherent characteristic of hard steels. It had been generally accepted that static strength in excess of 200,000 psi could not be used because of brittleness, notch sensitivity, and low fatigue life.

In the last few years, investigations have shown that these fears were not warranted. As a consequence, standard alloy steels such as SAE 4340 are now being satisfactorily heat treated to the 260,000-280,000 psi range. When used at this high strength level, the only significant pitfall for the designer is the comparatively low fatigue life shown in the low cycle range of the S-N curve for specimens having a notch which produces an effective elastic stress concentration factor of 3.0. In all other conditions, the ratio of the fatigue strength to ultimate strength is as good as that for steels in the lower heat treat ranges. Therefore, the only particular precaution to be taken when designing for the high strength is to be ultra-cautious in avoiding stress risers in those parts which are normally loaded to high stress levels, such as arresting gears, catapult hooks, etc.

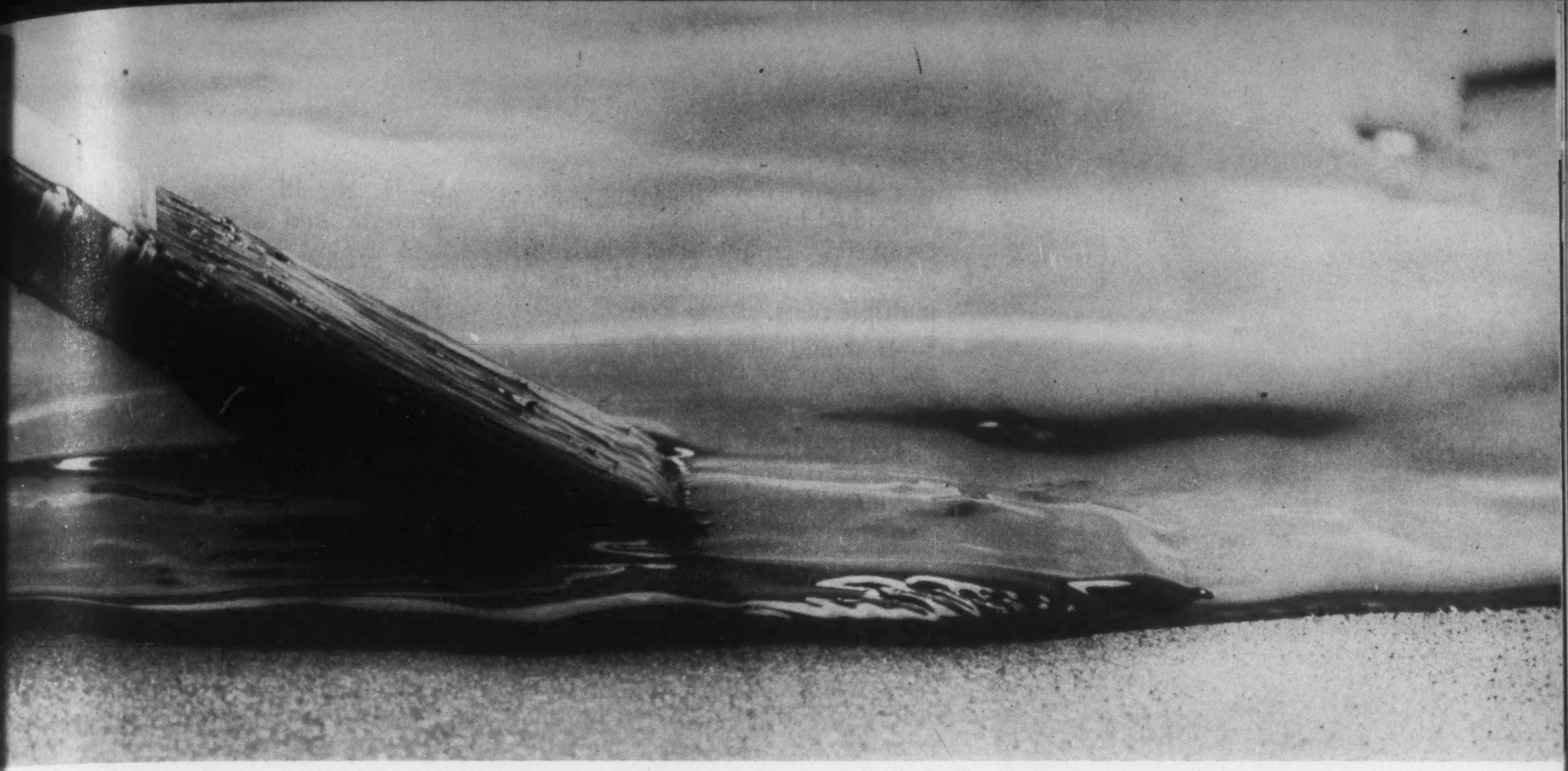
Some parts of an aircraft operate at comparatively low stress levels, but have required the use of stainless steel for the fabrication. These parts have been the firewall and nacelles for piston engines and shields or shrouds for jet engines. They act as radiation shields to protect the main structural elements from heat radiated from the engine. Also, in case of a severe fire in the engine space, these parts must maintain their structural integrity. Commercially pure titanium shows large weight savings when substituted for stainless steel in these low-stress applications. One case, in which this substitution was made, was the DC-7 nacelle which is similar to the DC-6 nacelle except that the latter is all steel while the former is all titanium except for a few highly loaded members.

The Future

The problem of the selection of the proper material for aircraft construction is one that is ever changing. The designer has been able to meet past challenges presented by the need of cleaner structures for aerodynamic reasons with conspicuous success. Future demands will be just as successfully met. The problems presented by aerodynamic heating will be particularly trying, but the outline presented here shows that speeds much greater than any feasible from a propulsion standpoint in the near future can be handled with the materials presently available. If new forms of propulsion plants, perhaps utilizing nuclear energy, move us into the questionable zone of the flight spectra of Fig 1, I am sure that the resourcefulness of the metallurgist and the designer will be ready to provide an aircraft which will allow us to use the full power of the propulsion unit. One approach to the problem is already being developed by the metallurgist. This is the use of the vacuum furnace in the production of various alloys. The elimination of gaseous impurities has proved to increase the strength of some alloys greatly at elevated temperatures.

The "thermal barrier" will be just as successfully passed as was the "sonic barrier". We will have to learn new methods and will, probably, face problems which are extremely difficult and complex. However, the tools available for the solution of these problems, both experience and elaborate electronic calculators, are becoming more accomplished and will be ready when called upon.

This article was adapted from a paper presented at the Aeronautic Meeting of the Society of Automotive Engineers, Inc., October 5-9, in Los Angeles.



Heavy solids neoprene coatings can be brush-applied in thicknesses of 15 to 20 mils per coat.

Neoprene:

Is It the Best All-Around Organic Coating?

Yes, says the author. He bases his opinion on the way neoprene, when compared with other organics, stacks up against what he believes are the ten important criteria for protective coatings exposed to chemical splash and fumes.

by **R. B. SEYMOUR**, President, Atlas Mineral Products Co.

● THERE IS NO MIRACULOUS organic coating today—no inexpensive, one-coat system that provides universal corrosion protection for structural materials. No coating is the equal of all others in all environments, and even the best must be applied in at least three coats and at least 5 mils thick when exposed to chemical splash or fumes. Accepting these limitations, however, which of today's organic materials comes closest to being the ideal protective coating?

First the criteria for an ideal protective coating must be established. The ten requirements listed in this article are believed to be both significant and realistic in terms of materials available today. And when the various organic coatings—vinyl, styrene copolymers, chlorinated rubber, Saran, epoxy and neoprene—are compared with these criteria, it becomes clear that neoprene is closest to being the all-around or "ideal" coating. Just how closely neoprene meets these requirements is discussed below.

1—It should adhere tenaciously to a properly prepared surface.

When applied over a chlorinated rubber-base primer on a sand-blasted steel surface, a 1-in. strip deposited from a liquid neoprene requires a pull greater than 20 lb for removal. Since the entire force operates at a small distance on the 1-in. cross section, the actual adhesion value per unit area is many times the force required to strip the film from the metal surface.

2—It should be capable of being readily sprayed or brushed on to yield a pinhole-free film having a minimum thickness of 2 mils per coat.

Properly compounded liquid neoprene coatings can be spray or brush applied to yield films at least 1.5 or 3 mils respectively. Specially compounded high solids coatings may be brushed on in thicknesses ranging from 15-20 mils per coat. As in the

Chemical Resistance of Compounded Liquid Neoprene Films

	75 F	160 F		75 F	160 F
ACIDS			SALTS		
Acetic, 10%	N	N	Alum	E	E
Chromic, 10%	N	N	Trisodium phosphate	E	E
Citric	E	E	Calcium Chloride	E	E
Hydrochloric	N^1	N^1			
Nitric, 5%	F	N	GASES		
Sulfuric, 50%	E	F	Chlorine	N^2	N^2
Sulfuric, 93%	N	N	Sulfur dioxide	E	E
			Hydrogen sulfide	E	E
			ORGANIC MATERIALS		
ALKALIES			Ethyl alcohol	E	E
Ammonium hydroxide	E	E	Benzene	N	N
Potassium hydroxide	E	E	Formaldehyde, 37%	E	E
Sodium hydroxide	E	E	Gasoline	G	F

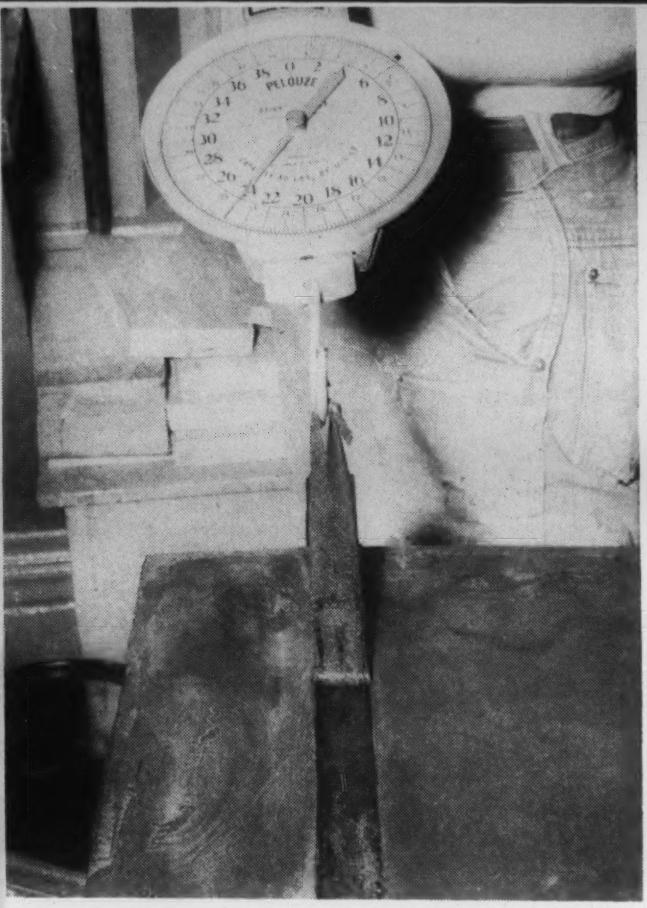
NOTES:

[1] *Permeation with concentrated solutions. Plant test required before use.*

[2] *Surface hardening. Plant test required before use.*

Ratings:

E = *No attack.*
G = *No appreciable attack.*
F = *Some attack but usable in some instances.*
P = *Attacked—not recommended.*
N = *Rapidly attacked.*



Note 24-lb pull registered in adhesion test on 1-in. wide strip of neoprene.

Neoprene coated H-beams after 2-yr exposure to marine corrosion.

case of other coatings, none of these individual films can be claimed to be completely pinhole-free. Such deficiencies usually can be overcome by multiple coats.

3—It should cure rapidly to form a film which is completely resistant to solvents, acids, alkalies and salts at temperatures up to 200 F.

Standard neoprene coatings, compounded shortly before application, lose their solvent content within a few hours at ordinary temperatures. After several days the film becomes completely insoluble in aliphatic solvents, such as mineral oil, kerosene and gasoline. Tensile strength of the neoprene film is unaffected by small amounts of swelling; volume increases greater than 100% are required before significant changes in tensile strength are noted.

An accompanying table shows the resistance of liquid neoprene coatings to a variety of corrosive media both at 75 and 160 F. As can be seen, neoprene films are attacked by oxidizing agents such as concentrated sulfuric acid, nitric acid, chromic acid, chlorine, chlorine dioxide, sodium hypochlorite and hydrogen peroxide. Neoprene films are permeable to, but not attacked by, concentrated halogen acids such as hydrochloric acid and hydrofluoric acid.

4—It should be unaffected by sunlight and weather.

Properly compounded liquid neoprene coatings are usually superior to other elastomers in their resistance to sunlight and weather, but are inferior to several organic protective coatings such as oil-base, alkyd and vinyl. Liquid neoprene films have generally proved satisfactory when exposed to weather in all parts of the country.

5—It should have high tensile strength and elongation.

A typical neoprene coating possesses a tensile strength at 77 F of 1600 psi with an elongation at break of 300%. In comparison, a minimum tensile strength of 1200 psi and an elongation of 250% is required by the U. S. Navy for propeller shaft coatings. Such high elongation values have been obtained with other coatings; however, they were obtained through plasticization at the expense of tensile strength.

6—Its properties should remain unchanged for long periods of time under ordinary service conditions.

The inherent elasticity of neoprene is essentially permanent since the material does not require the addition of plasticizers to attain flexibility. Plastics to which plasticizers have been added may lose flexibility by plasticizer bleeding or solvent extraction, but the elasticity of neoprene is destroyed only by oxidation. Oxidation involves attack of the unsaturated groups in neoprene by such materials as chlorine, nitric acid, etc., or by high temperatures.

7—It should be available in a wide variety of colors.

Since it is customary to reinforce neoprene with carbon, most neoprene coatings are black. The material by itself is light-yellow colored, but red, yellow, gray and black coatings have been produced. If both color and chemical resistance are required, it is often possible to over-coat neoprene films with pigmented, chlorinated rubber coatings which are available in a wide variety of colors.

8—It should not require special curing techniques and should be reasonably non-toxic to the applicator.

Index for Corrosion Resistant Coatings[a]

Coatings	Cost/Gal	Cost/Mil	Cost/Yr	Ease of Application	Resistance to						Total
					Temp	Weather and Sunlight	Solvents	Salts	Alkalies	Acids	
Neoprene	2	10	10	6	10	7	3	10	10	6	74
Styrene Copolymer	6	7	7	9	7	6	3	10	10	7	72
Vinyl	5	6	8	9	7	8	4	10	7	8	72
Chlorinated Rubber	5	5	7	9	6	7	3	10	10	8	70
Saran	3	5	6	9	7	7	5	10	7	9	68
Epoxy	1	6	7	7	9	6	6	10	7	6	65
Alkyd	7	8	2	10	5	9	2	6	2	4	55
Asphalt	10	6	3	9	2	5	1	10	7	5	58
Oil Base	9	9	1	9	3	10	2	5	1	2	51
Polyvinyl Acetate	8	6	4	9	5	7	2	3	2	3	49

NOTES:

[a] The values for each category are comparative, with 10 being the optimum. For the cost and "Ease of Application" categories, 10 indicates the least costly and the easiest to apply, respectively. In regard to the corrosive media, 10 indicates no attack, and lesser numbers indicate less resistance to attack. In the case of the acids and solvents, since none of the coatings listed are completely impervious, there is no 10 value given. The highest is Saran with a value of 9 for acid resistance, and Epoxy with a value of 6 for solvent resistance.

Standard neoprene coatings must be compounded on the job at the time of use. Such coatings cure fairly well at room temperature, but maximum tensile strength is seldom attained unless the coating is heated to a temperature of around 200 F. or above. If tensile strengths above 1000 psi are required the curing process may be accomplished by heating with hot water or live steam. However, physical and chemical properties of room temperature-cured neoprene coatings are generally superior to those of other protective coatings.

Neoprene coatings are supplied as solutions in aromatic solvents such as toluene or xylene. While these solvents are flammable and somewhat toxic the solvent content usually amounts to less than half of the total composition. It is recommended that the concentration of these solvents in the atmosphere never exceed 200 parts per million and that open flames or sparks be kept away during application. The explosive limits of toluene and xylene are from 1 to 7% by volume in air.

9—It should be economical and commercially available.

Though some neoprene coating systems cost more per gallon than other protective coatings, the cost per pound of solid neoprene deposited from solution is usually less than that of solids deposited from other systems. Since fewer coats are required to attain a specific end-coating thickness, application cost is usually lower.

Relatively expensive manufacturing equipment is required to produce liquid neoprene coatings; therefore they are not as available as some other coatings. Nevertheless, there are at least six manufacturers and over a dozen distributors of the material.

10—It should have a long record of successful performance.

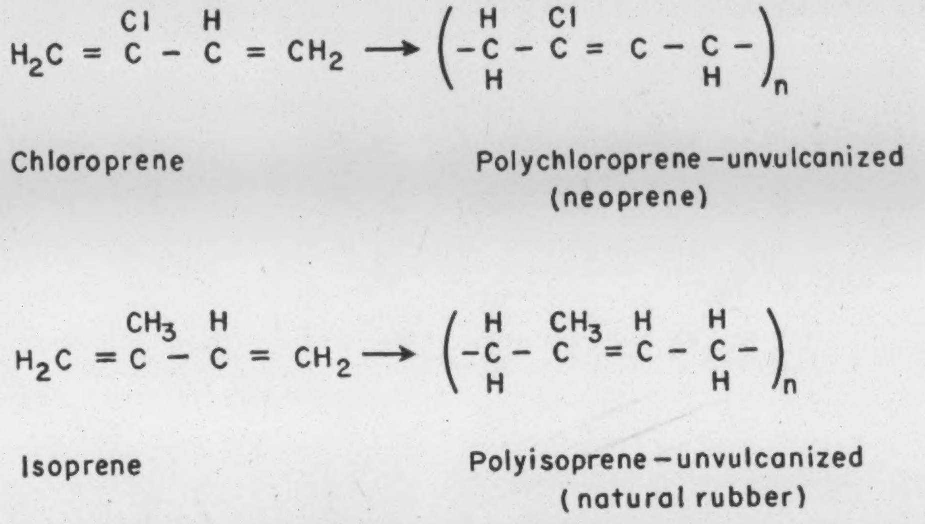
There are many case histories which could be discussed here. The following were selected to indicate the variety of uses for neoprene film and the length of service to be expected.

Ductwork—Sixty mils of a standard liquid neoprene coating were applied to ductwork exposed to both corrosive acids and traces of solvents in a chemical plant. The lining was in perfect condition after 8 years of service.

Concrete pipe — A 20-in.-diameter pipe was coated with about 40 mils of compounded liquid neoprene over a standard chlorinated rubber primer. The sections of lined pipe were joined by neoprene trowel cement applied to the tongues and grooves. The unlined pipe had had to be replaced after 12 to 18 months of service. The neoprene-lined pipe is still in use after 3 years exposure to sewage containing waste acids and corrosive salts.

Exhaust blowers—A lead-coated exhaust blower, exposed to sulfuric acid mist and fumes at temperatures as high as 180 F, was accelerated beyond the critical speed so that the lead coating failed. The fan was sandblasted and coated with neoprene to a thickness of 100 mils. It is still in good condition after 14 months of continuous service. Under the same conditions, 1/4 in. of uncoated steel plate was eaten away in less than 1 month.

Acid pickling tank—Too large to be transported economically to a sheet lining shop and too small to justify sending trained rubber lining crews to the job site, the tank was coated with a liquid neoprene lining averaging 100 mils in thickness. The lining was protected by brick, mortared with a furan cement. After several years of satisfactory operation, the steel cracked leaving an opening about 1/2 in. wide. The tank operated for 10 days, until replaced, without leaking any acid.



$$H_2C = \overset{Cl}{C} - \overset{H}{C} = CH_2 \longrightarrow \left(-\overset{H}{\underset{H}{C}} - \overset{Cl}{C} = C - \underset{H}{C} - \right)_n$$

Chloroprene

Polychloroprene—unvulcanized (neoprene)

$$H_2C = \overset{CH_3}{C} - \overset{H}{C} = CH_2 \longrightarrow \left(-\overset{H}{\underset{H}{C}} - \overset{CH_3}{C} = \overset{H}{C} - \overset{H}{\underset{H}{C}} - \right)_n$$

Isoprene

Polyisoprene—unvulcanized (natural rubber)

What is Neoprene?

As can be seen by the chemical formulas above, neoprene closely resembles natural rubber in its basic structure. Unlike natural rubber, which may be vulcanized with sulfur, neoprene is usually cured through the use of basic compounds such as litharge or magnesia. The former is most widely used in liquid neoprene compounding. The polymer chains of properly cured coatings are cross-linked to form a three-dimensional network which is no longer readily soluble in ordinary solvents.

The most widely used neoprene for liquid coatings is Type KNR, a sulfur-modified neoprene, which can be softened more readily by milling to form a high solids solution. Uncured neoprene is insoluble in acetone, ethyl alcohol and aliphatic hydrocarbons such as gasoline. It has limited solubility in ethyl acetate but is readily soluble in higher molecular weight esters and ketones as well as in chlorinated solvents such as carbon tetrachloride. It is readily soluble in aromatic hydrocarbons, such as toluene and xylene and most liquid compositions make use of these types of solvents. Neoprene coatings are available as standard or heavy coat liquid coatings, trowel cements or putties, ready-mixed coatings, and neoprene latex.

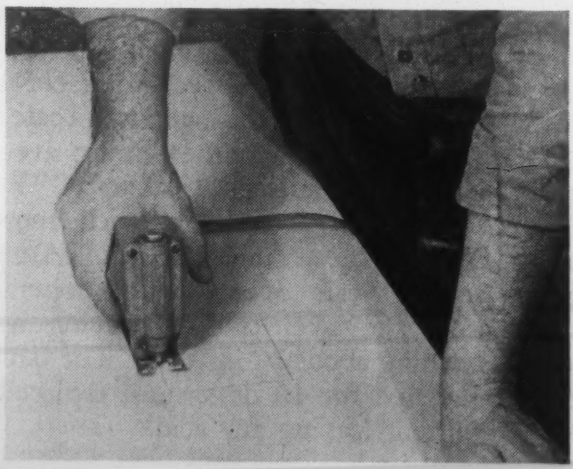
Adapted from a paper presented at the Tenth Annual Conference, National Association of Corrosion Engineers, March 15-19, 1954.

This 170-ft Marinite oven handles a complex baking cycle in the production of TV tubes.

Ship builders
Process industries
Metal producers
can use

New Structural Insulating Material

Three different grades give range of strength and insulating properties . . . all are corrosion resistant.



This rigid asbestos sheet material can be worked readily with ordinary tools.

A New Materials Preview

● MARINITE, A STRUCTURAL sheet material developed by Johns Manville for marine fireproofing, has recently found industrial applications in widely diversified fields ranging from ovens, where it functions both as structure and insulation, to equipment where it serves as a conveyor for liquid metal. Composed of asbestos fiber, diatomaceous silica and an inorganic binder, the material combines excellent thermal properties with good strength and light weight.

Three grades based on density are now in production. They were developed to give a range of strength and insulation properties. Superior insulating properties are obtained in one grade at the expense of strength, while superior strength is obtained in another grade at the expense of insulating properties.

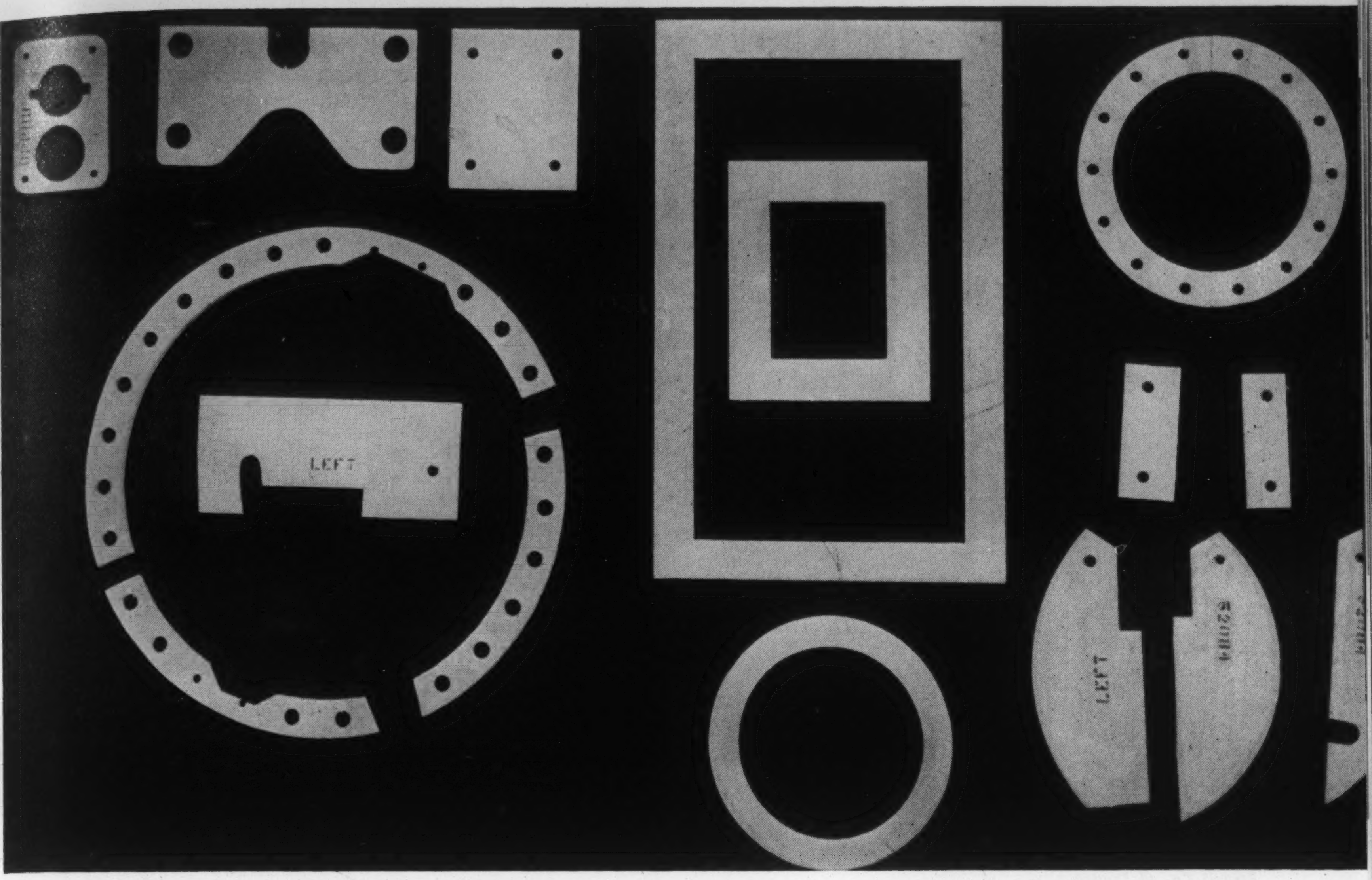
Properties

Some of the properties of these grades are given in the accompanying table. Thermal expansion of Marinite is quite low. The material can be used at temperatures up to 900 F, and thermal conductivity compares favorably with 85% magnesia insulating material. Transverse strength varies from 550 psi to 1500 psi for the three grades. Hardness of the general purpose grade is comparable to that of yellow pine. Marinite will not disintegrate upon long immersion in water and resists attack by many corrosive materials including some liquid metals.

Having a surface hardness comparable to yellow pine, Marinite can be worked without special tools and equipment. An ordinary carpenter's saw will cut it. However, the composition is such that wood-working saws dull rather rapidly and carbide-tipped saws or abrasive wheels should be used if extensive cutting is required. The material is readily drilled with the type and grade of drill used for steel. It can be nailed like lumber and fastened with screws.

Applications

Following the Morro Castle steamship fire, new regulations were drawn up which required the installation of fire screen bulkheads in American flag passenger vessels. Materials to be used for the purpose had to pass a Coast Guard test which specifies that bulkheads be so constructed that if subjected to the standard fire test reaching 1400 F in 15 min and 1550 F in ½ hr, they shall be capable of



The new material can be readily fabricated into special shapes.

preventing passage of flame for ½ hr. In addition, the insulating value must be such that the temperature of the unexposed side will not rise more than 250 F above the original temperature in 15 min. Marinite passed this test and has been installed on every American flag passenger ship built since the early 1940's and on the majority of American cargo vessels built during the same period.

Upon entering the industrial field, naturally the first applications were based on the insulating qualities of the material. Marinite was successfully used for boiler breechings in a large power plant. These breechings are hard to insulate because the expansion and contraction of the steel tends to cause cracking of the insulation.

Another application is the construction of ovens for handling a variety of products. These include ovens for bakeries, for drying coatings on stamped parts and wire forms, for baking television tubes, and for drying coated paper and textile products. Because of its strength, small gas fired ovens have been built of Marinite with no metal reinforcement. These ovens have been used for precipitation hardening beryllium copper, drying cores, baking molds, and similar operations where a moderate temperature between 250 and 650 F is required.

Marinite is used in the petroleum process industries to protect structural steel supports for equipment such as cracking units (cat crackers) from damage resulting from fire.

Since Marinite is not wet by molten aluminum, it has been employed for such equipment as launders and pouring spouts for transferring molten aluminum from furnace to mold and in hot tops for the molds themselves.

Typical Properties of Marinite

Grade	Marinite-23	Marinite-36	Marinite-65
Service	Heat insulation is major requirement	General Purpose	Strength is major requirement
Density, lb/cu ft (dry)	21–25	34–38	60–70
Normal moisture content, % of dry weight	5 (approx)	5 (approx)	5 (approx)
Moisture Exp. in./in.			
Shrinkage, normal-to-dry	0.0008	0.0011	0.0011
Expansion, dry-to-saturated	0.0010	0.0013	0.0013
Coeff of Exp/°F	2.0×10^{-6}[a]	1.3×10^{-6}[b]	2.6×10^{-6}[b]
Thermal Cond., Btu/sq ft/in./hr/°F			
at mean temp 100 F	0.55	0.76	1.50
400 F	0.60	0.79	1.68
600 F	0.63	0.81	1.80
Max Service Temp, F (continuous service)	900[c]	900	800
Mod of Elasticity, psi (transverse test)	1.5×10^5	4.0×10^5	7.0×10^5
Transverse Strength, psi (dry)	550	900	1500
Brinell hardness (dry)			
10 kg load, 10 mm ball, 10 sec	0.5	—	—
50 kg load, 10 mm ball, 10 sec	—	1.8[d]	4.6
Impact Resistance, in.-lb (6 lb wt. on 1 in.)	42	78	150

NOTES:
[a] *To 200 F, shrinkage above that temp.*
[b] *To 250 F, shrinkage above that temp.*
[c] *For temp above 400 F, two or more layers should be used if the thickness required is greater than 1 in.*
[p] *Comparable to yellow pine.*

The worn edges of a cookie cutting die are being built-up and hard surfaced by brush plating, using a cap type stylus at the Gondolo Biscuit Co. of France.

Brush Plating Now Practical

New improvements in old method make possible

- *Direct high speed plating on many metals*
- *High purity deposits*
- *Spot and selective plating*

by **MARVIN RUBINSTEIN**, Metal Finishing Consultant

● BRUSH PLATING has not been highly regarded as a general plating method because it has been slow, somewhat messy and unreliable from the standpoint of adhesion and quality of the resulting deposit. A relatively recent development called the Dalic Process, developed in the Dalic Laboratories in France, eliminates the disadvantages, yet retains the major advantage of brush plating, namely, the ability to selectively plate a restricted area with a small amount of equipment.

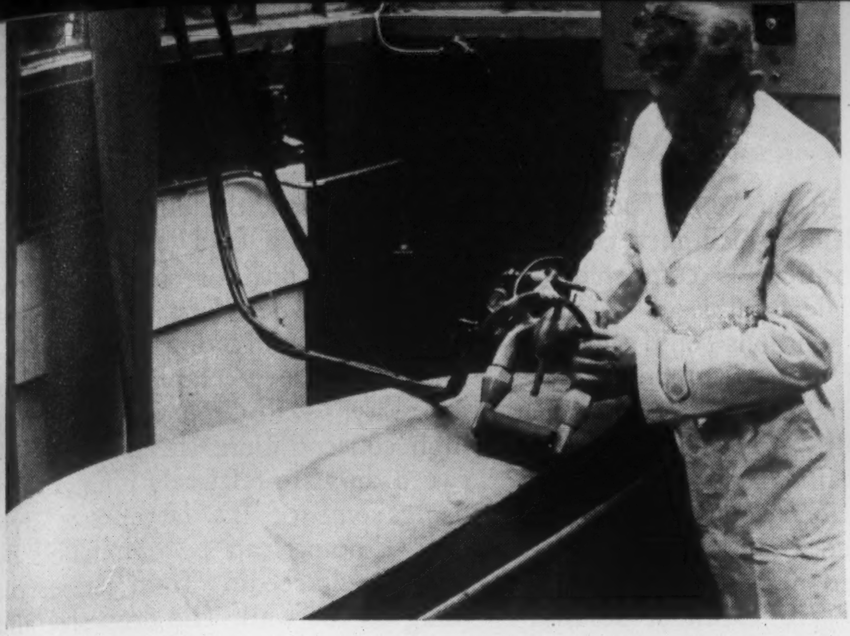
In the brush plating process, the work is made cathodic and a cotton swab saturated with an electrolytic solution is made anodic and run back and forth over the area to be plated. With the development of a new and unorthodox type of electrolytic solution and efficient styluses or "brushes", brush plating can now rapidly deposit metallic plates with a high degree of adherence and good physical properties.

Characteristics of the Plate

From the metallurgical standpoint, most Dalic Process plating results in deposits which are somewhat similar to those produced by ordinary bath plating. There are some important differences mainly due to the abrasion of the anode pad against the plating surface. This abrasion results in a high degree of adhesion without any special preparation or pre-etching of the surface. Since etching tends to decrease fatigue resistance, the elimination of the etch can be an important factor, particularly in such applications as aircraft parts.

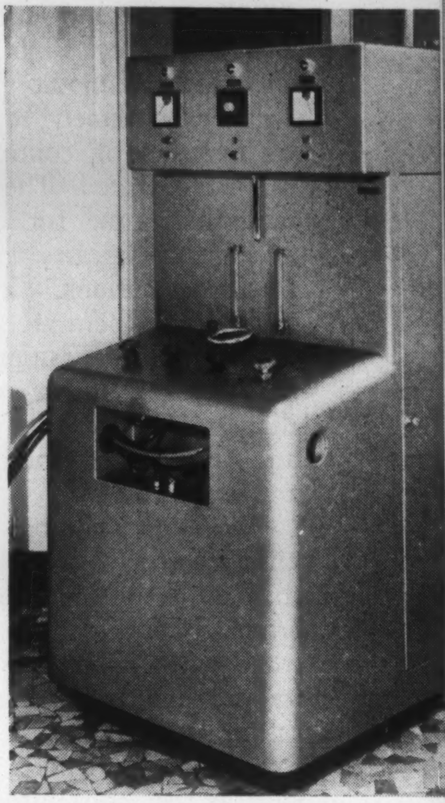
The abrasion also produces pore-free deposits, with the exception of the black nickel plate. Even the chromium plate has no pattern of fine cracks, and porosity tests on thin gold and thin chromium deposits over brass show no pores or cracks in the structure.

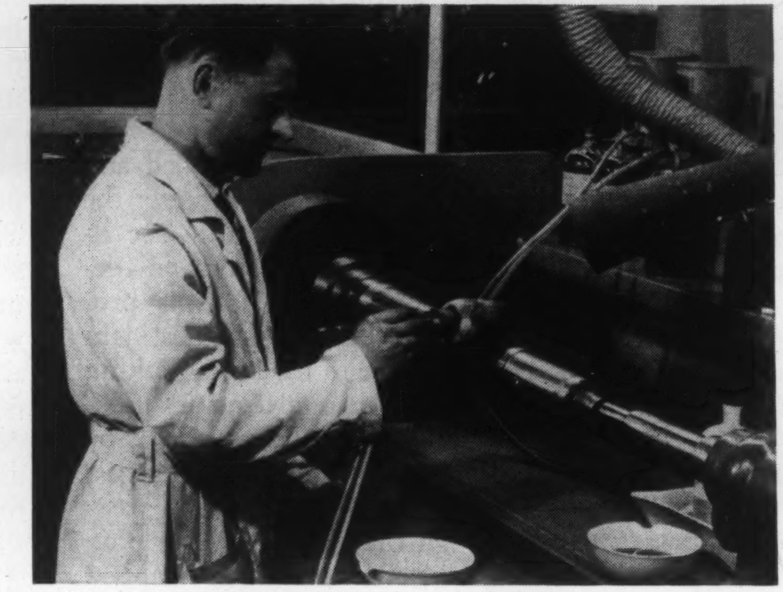
Another effect of the abrasion between the pad and the work is the good bond which can be obtained



Worn areas on this aircraft propeller are being refinished with zinc at the Air France repair depot with a drip-fed roller type stylus. The self-contained rectifier unit can be seen in the background.

Specially designed for use with the roller stylus, this 60-amp, 30-v self-contained rectifier incorporates a drip feed mechanism and an automatic drop timer.





Rotating slowly on a lathe, this worn shaft is being built-up using a plug type stylus, wrapped in cotton, at the Somua plant, French manufacturers of heavy industrial equipment.

with most Dalic solutions while plating directly on both aluminum and stainless steel. No zincate dip or Wood's nickel prime is needed. The only preparation required is a wet pumice or a vapor blasting of the surface.

There is little or no hydrogen embrittlement in Dalic deposits. This may be due to a combination of surface abrasion and high cathode efficiency of the solutions. The deposits are usually harder than those obtained by bath plating, probably owing to the higher current densities used in the new process. The higher hardness is particularly true of gold plating, where a 24 karat gold plate approaches in hardness that of 14 and 18 karat alloy gold plates produced in a bath. The major exception to this is the chromium plate which has a Brinell hardness of 600 as compared with 1020 for bath plating.

At the present stage of development, all Dalic plating is bright only in films of 0.0005 in. or less. In ordinary plating thicknesses the deposits have a dull finish, which can of course, be polished. Work is presently being done on developing brighteners for these solutions.

The limitations of coating thicknesses are given in the accompanying table. If a chromium finish is required and the thickness of build-up must be more than 0.005 in., a laminated deposit of copper-nickel topped with an 0.0005-in. chromium layer is ordinarily used. As can be seen from the table, there has been no limiting thickness found for copper, silver, gold, zinc, cadmium, indium, lead, thallium and gallium. Gallium, however, due to its low melting point (almost room temperature), tends to run at appreciable thicknesses.

New Solutions Developed

The new solutions, developed by Dalic Laboratories are the main key to the improvements made in brush plating. The solutions are highly concentrated, are designed to plate at extremely high current densities, and are non-toxic; they will not harm the skin or give off objectionable fumes when plated at high temperatures and current densities. They are metallo-organic compounds which do not tend to oxidize the surface being plated. They contain alcohols which tend to dissolve slight grease films at the surface; contain wetting agents ensuring good contact with the surface; and they operate without decomposition at boiling temperatures, so that they help clean the work surface during plating. These factors produce deposits with a high degree of adhesion.

The high concentration of the solutions allows a large number of metallic ions to be held in a small cotton swab. Dalic rhodium plating solutions, for example, contain about 20 gm of rhodium per liter, the nickel and zinc baths have a concentration of approximately 13 oz per gal of solution, and the cadmium bath has 27 oz per gal. The silver solutions contain roughly 33 troy oz of silver per gal.

The solutions are designed to plate at unusually high current densities ranging from 300 to 6000 amp per sq ft of contact area. At these current densities, if the part to be plated were ½ sq ft in area and the anode pad were 2 in. square, the effective current density over the entire part would amount to anywhere from

16.5 to 33 amp per sq ft, depending on the metal being deposited. Thus, where the area of the surface to be plated is only slightly larger than that of the anodic pad in contact with it, extremely rapid production of deposits of controlled thickness can be obtained. The accompanying table lists time for deposition and average thicknesses for a variety of plating solutions. In addition to those listed there are solutions available for the deposition of brass and black nickel, and a number of auxiliary solutions for electrocleaning and derusting, anodizing, etching and stripping.

The Dalic solutions are exceptionally free of impurities, and since they are kept in a closed container from which the anode pad is replenished when it becomes dry, this purity is maintained. Additional purification treatments can be applied to the solutions where special work, such as that encountered in the electronics industry, requires the highest order of purity.

Though several of the solutions (e.g., copper and nickel) are made in either acid or alkaline compositions to serve various needs, they are all relatively neutral, with pH factors ranging from 3.0 to 8.5. Cathode current efficiencies are high for most metals. For example, the copper solution has a 100% efficiency, the silver and lead have a 98% efficiency, and that of the chromium solution varies from 30 to 35%. The latter is also trivalent, which increases its rate of deposition as compared to normal hexavalent baths.

The Dalic solutions could conceivably be used in bath plating; however, contamination would occur and, since they boil away quickly, problems in the maintenance of bath level and composition would be encountered. In an enclosed bath, operating under reduced pressures, the solutions would give excellent results; however, for the present-day plating shop, this would be impractical.

Equipment and Operation

Three types of styluses or "brushes" have been developed and are now in use with the process: the cap, plug, and roller stylus (see illustrated box for construction details). A cooling apparatus is provided for all but the smallest laboratory sizes due to the heat resulting from the high current densities used. This cooling is usually carried out by aluminum fins, though the largest sizes have water cooling coils passing through the stylus. On the plug type stylus, cotton batting is wrapped around the carbon plug; on the cap type the cotton is held in place by the claws on the plastic cap; on the roller type, the cotton is held in place either by a rubber band or by a nylon or Terroline sleeve or stocking.

In operation, the electrolytic solution is usually kept in a porcelain evaporating dish or similar shallow glass receptacle. The cotton-tipped stylus is regularly dipped in the solution whenever replenishment is necessary. With solutions of such high concentration, the intervals between dips are relatively long. When using some of the larger size styluses, dipping can be eliminated by gravity drip-feeding from a reservoir hung on the wall. The drop size and rate can be automatically controlled to maintain the proper amount of solution in the cotton at all times.

Preparation of the work surface usually consists of derusting by any conventional method. Some parts may also be prepared with emery, pumice or alumina, though this is usually only necessary for aluminum, stainless steel and other hard-to-plate metals. The surface is then cleaned with the Dalic electrocleaner (which also provides a light derusting action), rinsed with water and plating can begin. The same electrocleaner is used for both ferrous and nonferrous metals.

Applications

Build-Up and Repair — Copper, nickel and chromium are widely used for build-up work. The nickel-copper laminate with the chromium final finish can be applied with relative ease since the switch from copper to nick-

Characteristics of Dalic Process Solutions and Deposits

Metal or Solution	Properties of Solutions						Characteristics of Deposits				
	Current Density, Amps/sq ft			Approx Metal Content, oz/gal	Avg Time to Deposit 0.001 in., sec[c]	Avg Thickness in 1 min, 0.001 in.[c]	Brinell Hardness	Temp at Fusion, F	Elect. Res., per cm, —4 F	Density, gm/cm³	Present Limiting Thickness, mils
	Conventional Baths	Dalic Solutions									
		A[a]	B[b]								
Bismuth	—	700	1400	—	76.2	0.79	50[e]	520	115	9.8	3
Cadmium	10–50	900	5600	27	25.4	2.4	40[e]	610	7.7	8.7	[f]
Chromium	100–400	1900	3700	11	635	0.095	600	3490	14	7	0.5
Cobalt	—	700	1400	—	76.2	0.79	250	2695	9.7	8.7	5
Copper	25–250	900	5600	9.5	25.4	2.4	150	1980	1.6	8.9	[f]
Gallium	Non-existent	500	900	—	178	0.34	—	85	50	6	[g]
Germanium	—	1900	3700	—	—	—	—	1760	(300)	5.5	0.1
Gold	2–50	300	1900	12[d]	76.2	0.79	100[e]	1940	2.4	19.3	[f]
Indium	20–100	900	3700	—	25.4	2.4	<1	305	8	7.3	[f]
Iron	20–200	900	2800	—	102	0.59	175	2790	10	7.8	1.5
Lead	5–80	900	4700	—	25–51	1.6	20[e]	625	19	11.3	[f]
Nickel	10–100	1200	4700	13	50.8	1.2	500	2645	6.7	8.9	5
Palladium	10	300	1400	—	102	0.59	150	2825	11	11.9	—
Platinum	10–120	900	2800	4.9[d]	178	0.34	200	3220	10.5	21.4	5
Rhodium	10–80	1400	2800	2.4[d]	1020	0.059	500	3565	5	12.4	1
Silver	5–100	700	1200	34[d]	50.8	1.2	60	1760	1.6	10.5	[f]
Thallium	—	1400	1900	—	102	0.59	—	575	17	12	[f]
Tin	30–400	1400	4700	9.5	25.4	2.4	1[e]	445	13	7.3	15
Zinc	5–100	900	2800	13	25–51	1.6	70[e]	785	6	7.1	[f]

NOTES:

[a] *Not cooled or slightly air cooled.*

[b] *Water or refrigerant cooled anode.*

[c] *Over an area equal to that of the contact pad of the anode.*

[d] *Troy oz per gal.*

[e] *Approximate value.*

[f] *Infinite.*

[g] *No limit metallurgically speaking, but tends to run at appreciable thickness.*

el and back involves only a rinse from a water hose, and a change of stylus. Silver, lead, indium and tin are also used for build-up work such as aircraft bearings. The ability of brush plating to selectively plate limited areas makes it well suited for this use.

Surfacing to Reduce Friction—To reduce friction on tools, dies and moving parts, chromium plating may be used. Tin plating may be used to reduce seizing on some types of aircraft and machinery parts.

Electrical Contacts—In the case of many electrical contact elements, only a small area of the component requires plating. With the Dalic Process a tiny section of a large part can be gold or silver plated for conductivity, and/or rhodium plated for abrasion resistance, in large quantities at a comparatively low cost.

Plastic-Metal Combinations—Metal inserts or contact faces in molded plastics parts can be easily plated, whereas with bath plating, distortion or moisture absorption in the plastic material can cause difficulty.

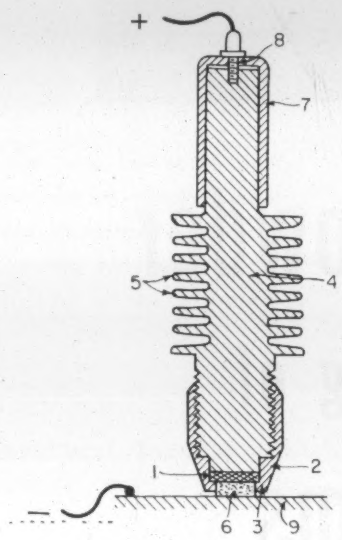
Electronics and Spectro-Analytical Equipment—The purity of the resulting plate makes Dalic plating advantageous for such components as make-break switches, cavity resonators, radar wave guides, and particulary for use in giving comparative wave characteristics in spectographic analytical equipment.

Cold Welding—A thin plate of either indium or gallium on two mating, non-ferrous surfaces, followed by hand pressure at room temperature for gallium, or in a low-temperature furnace for indium, results in diffusion of these metals into both surfaces, producing a tight seal. The cold welding technique finds use in certain methods of vacuum tube manufacture.

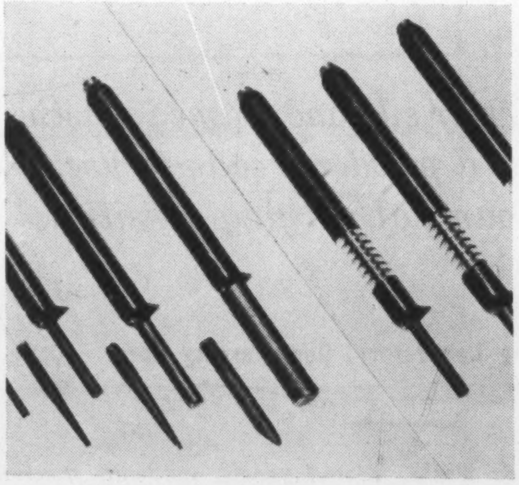
Strip and Wire Plating—The process is well suited to automatic operation for plating strip and wire. For this application, the strip or wire unwinds from a reel and passes progressively through a series of sponges fastened to styluses for electrolytic degreasing and derusting, rinsing and plating. The rinsing is a spray operation, while the cleaning and plating sponges are drip-fed at the rate required to maintain sufficient solution for plating.

Other Uses—There are a multitude of other uses for which the Dalic Process can be used advantageously. Among these are preplating for rubber bonding; plating jewelry; selective plating as a stop-off for case hardening; plating optical equipment; plating parts which are difficult to dismantle or stop-off, and, of course, the original application of brush plating, namely for touch-up work. The new process is not intended to replace bath plating, but it should become an additional tool in the plating shop. Possible future applications of the process are limited only by the imagination of the electroplater.

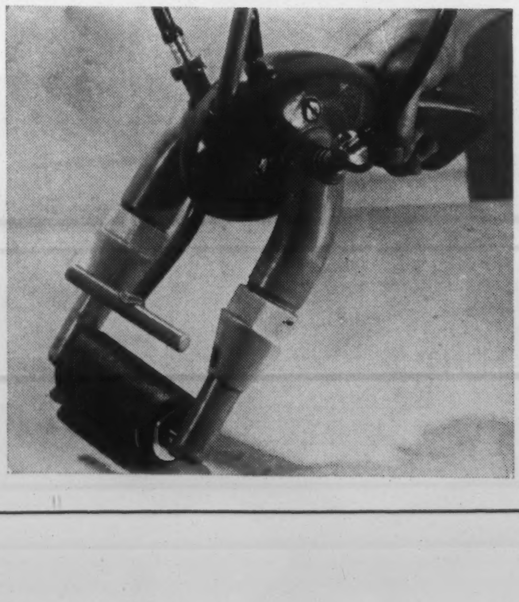
Types of "Brushes"



Cap Type Stylus — Carbon disk (1) is held in place by seat (3) of insulating plastic cap (2). The aluminum core (4) screws into the cap and is provided with cooling ribs (5) to dissipate heat evolved during plating from cotton pad (6) which is held in place between the seat and the plug. The aluminum core is covered with an insulating material (7). The positive lead from the rectifier is plugged in at the female contact (8) while the work (9) is connected to the negative pole.



Plug Type Stylus—The plug styluses shown at left have no cooling facilities and are used only for laboratory work requiring no more than 2 or 3 amps. The industrial sizes at right have aluminum cooling fins and will handle up to 15 amps in the largest size. The carbon plugs are available in a variety of shapes. Cotton wool is wrapped around the plug for plating.



Roller Type Stylus—In this large size, cooling water enters at inlet near top of handle, goes down through the roller and comes out near top of other handle. The third tube suspended over center of roller is drip-feed mechanism which supplies electrolyte from reservoir at the same rate as it is being used. Carbon roller is wrapped in cotton wool for plating.

Availability

Since there are no present licensees in this country, the process is commercially available only in Britain or Europe. However, there are several U.S. companies developing processes along a similar line.

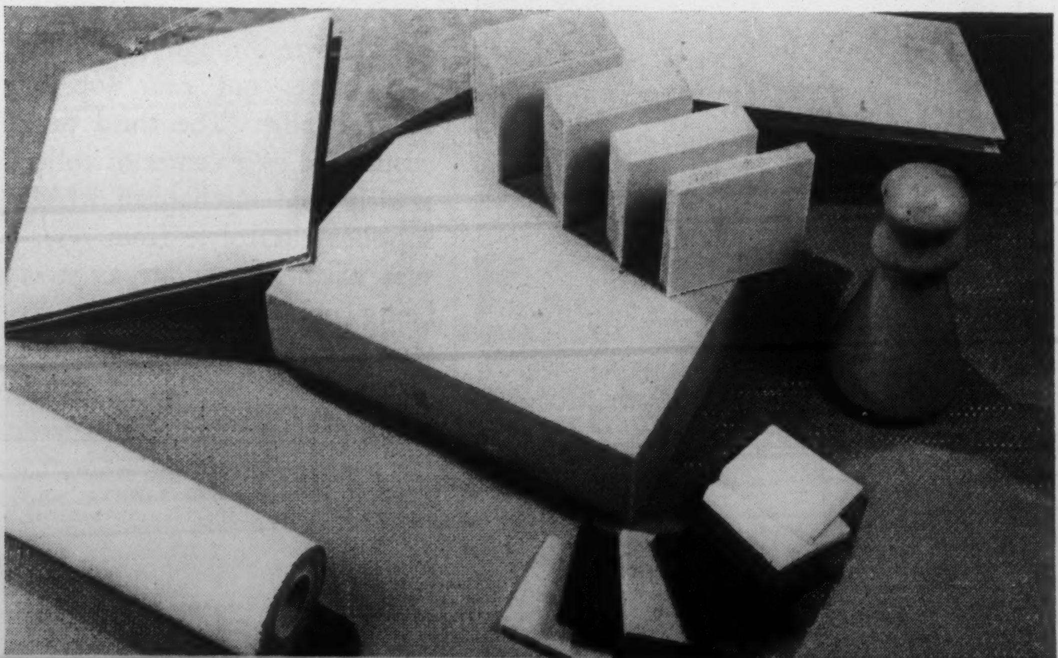
Heat converts 150 gm of powdered resin (upper left) to a ½-liter of cured silicone foam (above).

Pre-Mixed Powder Simplifies Forming of Silicone Foams

Similar in properties to former silicone foamed plastics, this material is supplied as a powder, ready to use. Only heat is required to expand the powder to foams of varying densities.

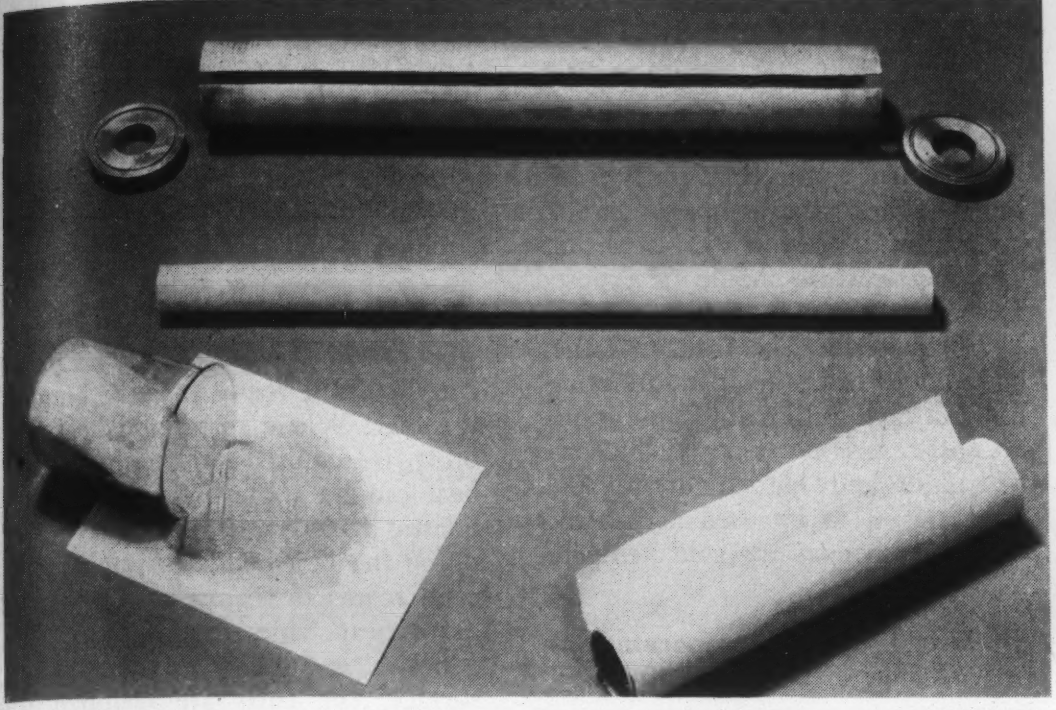
by D. E. WEYER, Product Engineering Laboratory, Dow Corning Corp.

Typical samples of foamed shapes include blocks, colored panels, sandwich structures, a tube and the shape produced by foaming in the ½-liter flask. Sandwich structure at top employs skins of 6-mil aluminum sheet.



● HIGH TEMPERATURE SILICONE FOAMS can now be produced merely by heating a pre-mixed powder. The dry powder contains exact proportions of resin, filler, blowing agent and catalyst; no further mixing or processing is necessary. A predetermined amount of powder is poured into a cavity or mold and heated at a selected temperature depending on the density of foam desired. A uniform density can be held consistently within plus or minus one pound per cubic foot.

Properties of the resultant foamed structures are similar to those of Dow Corning XR-543 and XR-544 (M&M, November, 1953). However, XR-543 and XR-544 are supplied as solid resins which must first



Components for a foam-insulated tube include metal mold and end caps for outer wall, silicone-glass laminated tube for the core, a beaker of resin mix and roll of asbestos paper which will form the outer wall over the foam insulation. The core is placed inside the metal mold which is lined with the asbestos paper. Resin mix is poured between the core and the paper, expanded and cured. The completed foam-insulated tube is then withdrawn from the metal mold.

be melted and mixed with a catalyst and blowing agent before being poured into the mold. The new powder form eliminates the time, equipment and care formerly required to mix the reagents and prepare the materials to produce foamed silicone plastics.

Typical Properties of Silicone Powder Foam Mixes

	R-7001	R-7002	R-7003
POWDER			
Color	Tan	Tan	Tan
Apparent Density, lb/cu ft	45	46	46
Mesh Size, approx.	20	20	20
Melting Point, F	200	200	200
Shelf Life, mo	9	9	9
EXPANDED			
Expansion Temperature, F	320	320	320
Density, lb/cu ft	12	14	16
Cell Size, in.	0.08	0.08	0.08
Compressive Strength, psi			
at 77 F	100	175	325
after ½ hr at 500 F	5	25	75
after 200 hr at 500 F	25	20	70
Weight Loss, %			
during expansion	1.2	1.3	1.0
after 200 hr at 480 F	2.1	2.1	2.1
after 200 hr at 570 F	4.0	3.2	3.4
after 72 hr at 700 F	8.5	5.2	5.2
Water Absorption, % by wt			
after 24-hour immersion	3.2	2.3	2.1
Heat Distortion Temperature, F	700	700	700
Flame Resistance	Does not burn	Does not burn	Does not burn
Thermal Conductivity[a]			
Btu/in./°F/sq ft/hr	0.3	0.3	0.3
Dielectric Constant[b]			
(8.5 x 10^9 cycles/sec)			
at 77 F	—	—	1.26[c]
at 500 F	—	—	1.37
at 77 F, 24 hr wet	—	—	1.27

NOTES:

[a] *At 11 lb/cu ft density.*

[b] *At 13.3 lb/cu ft density.*

[c] *All three powders have essentially the same electrical characteristics. Other powders can be formulated with dielectric constants from 1.2 to 7.0.*

Three Types of Powder

Three types of powder have been developed: R-7001 can be foamed to densities ranging from 10 to 14 lb per cu ft; R-7002 to densities ranging from 12 to 16 lb per cu ft; and R-7003 to densities of 14 to 18 lb per cu ft. The first two powders may be foamed in place; R-7003 can be foamed satisfactorily only in block or sheet form, but is stronger and retains more high temperature compressive strength than the other two.

Foamed structures produced from R-7001 are the most resistant to thermal shock. Samples have been cycled repeatedly between room temperature and 600 F without cracking. Samples have withstood 700 F for 72 hr with only slight dimensional change. Total weight loss at the end of this period was less than 10%. When subjected to direct flame, only slight surface decomposition was encountered. Though the foam has good compressive strength at room temperature, it loses most of its original strength at elevated temperatures and becomes soft and rubbery. This thermoplastic tendency can be advantageous for forming the foam to a desired shape before final post-curing. After the initial expansion, sections can be cut from the foam and heated again to temperatures around 200 F. At this temperature the foam softens and can be wrapped around such shapes as air ducts, pipes and tanks. This procedure is recommended where foaming in place is not feasible.

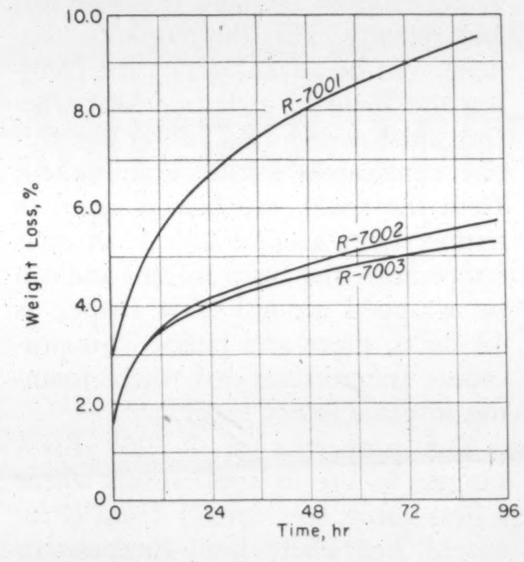
The properties of R-7001 foam suggest its use in applications where a heat-stable, low density foam is required, but where high compressive strength at elevated temperatures is not essential. Because it is resistant to thermal shock, nonflammable, and has a low thermal conductivity value, R-7001 serves as an excellent thermal insulator.

Although similar to R-7001 in most respects, R-7002 retains a considerable amount of its compressive strength at elevated temperatures. When used as a structural member at elevated temperatures, foamed R-7002 should be post-cured for 48 hr at 480 F to increase its high temperature strength. In other applications, the foam will cure and become stronger with use.

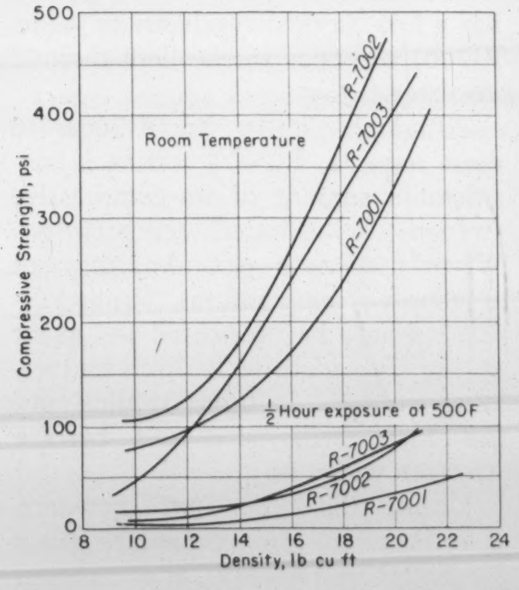
Unlike the other two powders, R-7003 cannot be foamed in place satisfactorily. However, it is stronger and retains considerably more compressive strength at high temperatures. The foam can be cut or carved, or machined to close tolerances. Sandwich structures can be made by bonding various types of skins to a pre-shaped block or sheet with adhesives.

Foaming and Fabrication

Silicone foams, when foamed in place, will adhere to most metals and glass cloth laminates. For maximum adhesion to the cavity walls, the surfaces should be sanded lightly and coated with silicone resin R-548. R-548 is supplied as a 50% silicone resin solution in toluene and can be applied by either brush or spray. The primed surface should then be heated for 3 or 4 min at 300 F to drive off the solvent. The number of pounds of powder required to fill a given cavity can be calculated by multiplying cavity volume in cubic feet by the foam density at the expansion temperature. For a more uniform cell structure, about 10% excess powder should be added to assure an overflow.



Average weight loss at 700 F for the foamed silicone resins.



Average compressive strength values of the foamed silicone resins.

The molds do not require preheating. The powder is poured into the cavity, and heat is applied. Heat may be supplied by air circulating ovens, strip heaters, heat lamps or similar equipment. To insure against shrinkage, the structure should be exposed to the expansion temperature for an additional 4 hr. The foam may then be removed or the temperature raised for post-curing. In many applications, no post-cure is necessary as the foam will cure and harden during use. Where it is to be used as a structural member at elevated temperatures, a cure of 48 hr at 480 F is recommended. For sections 1/3 to ¼ in. thick, the post-cure can be decreased to 24 hr at 480 F. After the recommended post-cure, the structure will have approximately 90% of its maximum high-temperature strength.

Effect of Foaming Temperature on Density of Silicone Foams

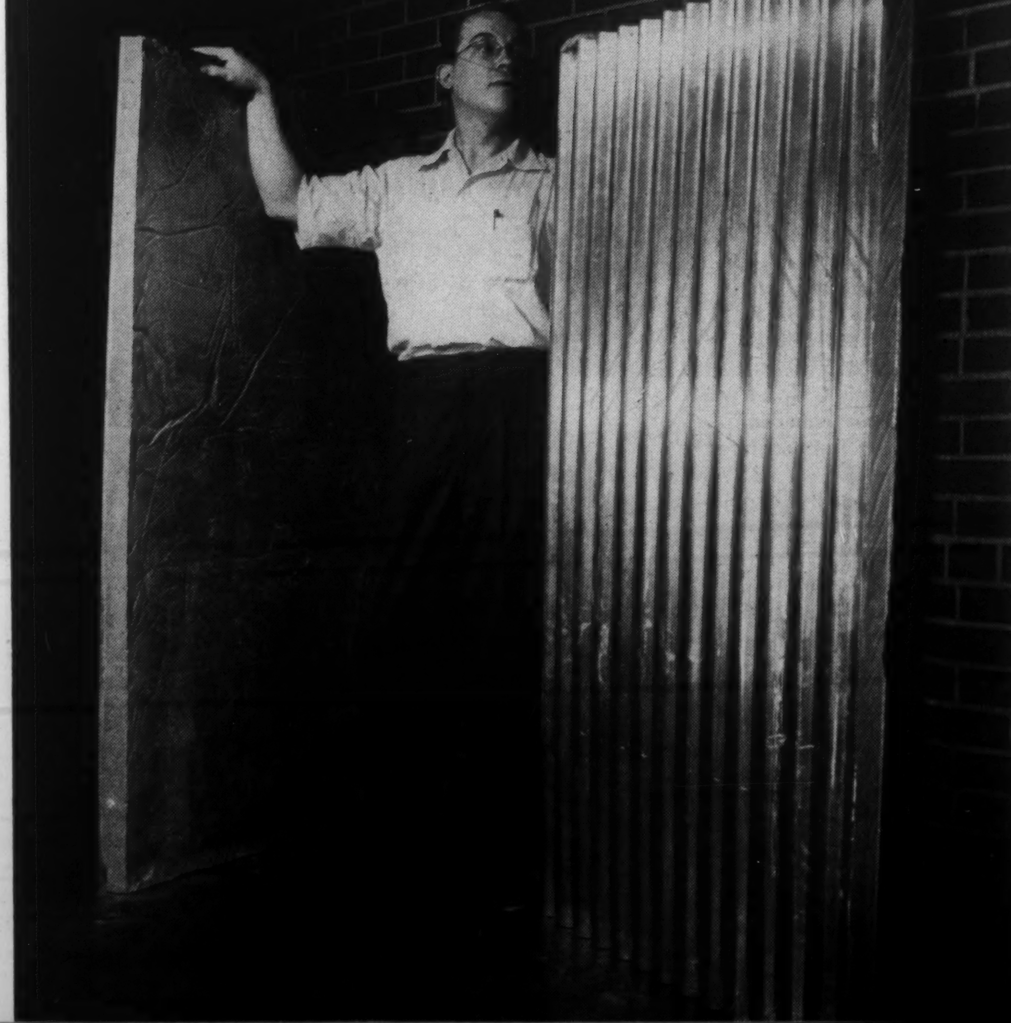
Expansion Temperature, F	Density, lb/cu ft[a]		
	R-7001	R-7002	R-7003
300	14	16	18
320	12	14	16
340	11	13	15
355	10	12	14

[a] *These density values will vary slightly depending upon the size and shape of the cavity.*

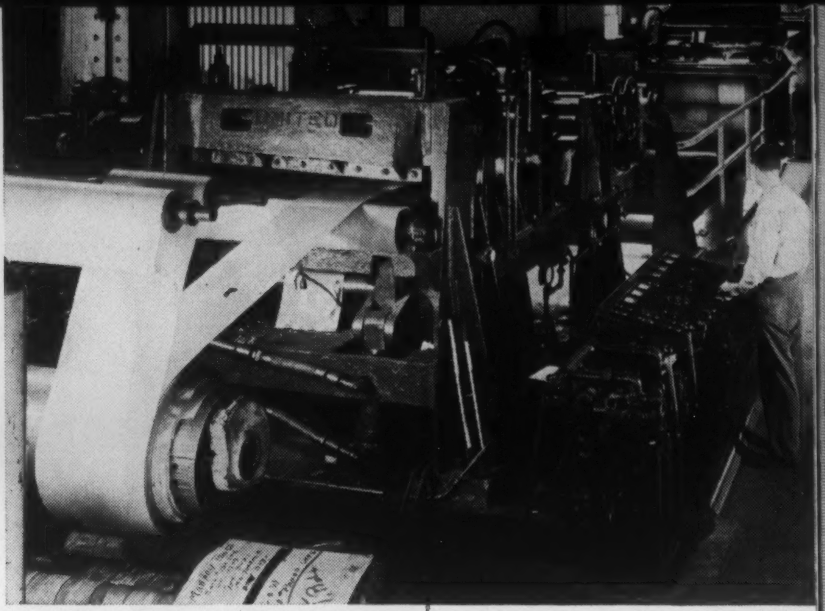
Bonding the Cured Foam

For some types of fabrication, cured silicone foams must be bonded together. Where maximum heat stability is required of the bond and heat can be applied during joining, Silastic S-2007 and S-2031 have produced the best bonds in joining silicone foams to themselves, to metals or to heat-stable plastics skins. The adhesive is applied to the bonding surface, the parts are clamped together and heat is applied to vulcanize the adhesive. Silastic S-2007 offers the best bond at temperatures of 500 F. Silastic S-2031 produces a bond of equivalent heat stability but somewhat lower physical strength, and may be used where a more fluid paste is desired. For those applications where it is not possible or desirable to apply heat during curing of the adhesive, RTV Silastic may be used. It vulcanizes at room temperature to produce a good bond which is stable at temperatures up to 400 F.

These two sections of insulation walls are said to be the largest silicone foam fabrications poured. The two sections are poured back to back, with aluminum foil separating them. The outer sides are foamed against corrugated aluminum panels.



How To Avoid Titanium Embrittlement During Pickling



Continuous pickling line used for Rem-Cru titanium and stainless steel in the Midland Plant of Crucible Steel. Strip passes through an annealing furnace, through line of pickling tanks and over coilers in the foreground.

by **H. B. BOMBERGER, M. B. VORDAHL and W. L. FINLAY,**

Rem-Cru Titanium, Inc.

● HYDROGEN CAN BE a serious embrittling agent in titanium and its alloys. Rem-Cru has recognized this for several years and has produced titanium mill products from low-hydrogen sponge, melted under vacuum with an inert gas sweep to minimize the hydrogen content.

Since the production of many titanium mill products, particularly sheet, includes repeated acid pickling operations, the minimization of hydrogen pickup during acid pickling is very important. For this purpose a satisfactory acid pickling bath for titanium with minimum hydrogen pickup was developed.

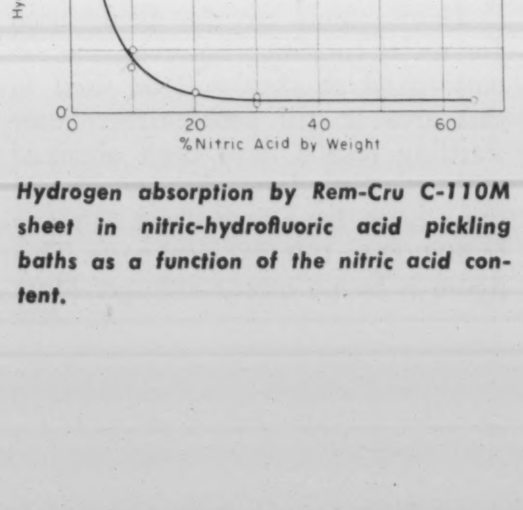
The most common pickling solution used for titanium is the conventional 10% nitric-2% hydrofluoric acid bath used to brighten stainless steel. Although this pickle gives a satisfactory surface finish to titanium, it can result in the absorption of an undesirably large amount of hydrogen.

Test Methods

Test specimens of C-110M, an alpha-beta Ti-8% Mn alloy were used. These specimens, 0.050 x 1 x 6 in., were first vacuum annealed at 1500 F for ten hours to a final pressure of less than 0.1 micron, then exposed in one liter of test solution at 150 F to remove 0.004 in. from the thickness. Hydrogen determinations were made by the vacuum discharge method at 1500 F with an uncertainty of about 0.004%.

Investigation of a number of acid systems, to determine if titanium could be pickled without suffering hydrogen embrittlement, showed that most acids do not dissolve titanium at a practical rate. Those which do, such as hydrofluoric, hydrochloric, sulfuric and phosphoric, embrittle the metal with hydrogen. In an effort to suppress hydrogen pickup, several oxidants were added to these acids but most combinations resulted in a marked reduction in pickling rate. Fortunately one was found which dissolved titanium readily and uniformly in the presence of oxidants. This was a combination of a fluorine acid or salt (e.g. HF, HBF_4, NaF and $NaBF_4$) and strong nitric acid.

The figure shows the weight percentage of hydrogen absorbed under the test conditions. Hydrogen pickup is clearly a function of nitric acid concentration. In a solution of 2% hydrofluoric acid containing no nitric acid, about 0.14% hydrogen was absorbed. Additions of nitric acid up to 30% reduced this to a base value of about 0.004%.



Hydrogen absorption by Rem-Cru C-110M sheet in nitric-hydrofluoric acid pickling baths as a function of the nitric acid content.

The use of the conventional pickle of 10% nitric-2% hydrofluoric acid can result in a pickup of 0.02%. However, the nitric acid is depleted during operation of the bath so that in a used bath hydrogen absorption may be many times greater, as indicated by the curve at lower nitric acid content. This can be especially true if the hydrofluoric acid is replenished without adequate nitric acid additions.

The chemistry of pickling in a strong nitric acid solution appears to agree with the following chemical reaction as determined by dissolving known amounts of commercial titanium in a solution of known content followed by analysis:

$$3Ti + 4\,HNO_3 + 12HF \rightarrow 3TiF_4 + 8H_2O + 4NO$$

The evolution of nitric oxide (NO) occurs but it is immediately oxidized to the brown nitrogen dioxide (NO_2) on exposure to air. The exact form of the titanium fluoride complex is not known, but it appears to take some part in the pickling action, for depletion of the hydrofluoric acid does not seem to occur as rapidly as indicated, and a white precipitate, presumably titanium dioxide (TiO_2), may form in an old bath.

The pickup of hydrogen by titanium and titanium alloys on acid pickling can be greatly minimized by maintaining a high oxidizing strength in the bath through periodic analyses and replenishing. Therefore processers of titanium and titanium alloys should maintain the nitric acid content of acid pickles above 20%.

This male phenolic mold is used to lay-up the inner skin of a foamed-in-place, sandwich-type radome for aircraft at Brunswick-Balke-Collender. (Marblette Corp.)

Plastics Tooling—

its Place in Industry

by MALCOLM W. RILEY, Assistant Editor, Materials & Methods

Part I

What is the present status?
Which materials are being used?
What direction is resin development taking?

This first of two articles gives the answers based on industry's experience to date.

● INDUSTRY HAS DEFINITELY ACCEPTED plastics tooling. It has proven itself for assembly and checking fixtures and for duplicate die models and prototype work. It is also becoming established in the plastics-forming field for molds used in bag molding, hand lay-up work, and vacuum-forming.

Plastics tools are also being used for metal forming; however, the extent to which they will be used in this area is still problematic. Some startling results have been obtained with plastics draw dies which, in some cases, have turned out as many as 50,000 to 100,000 steel parts. This figure is by no means average. More likely a plastics die will be used to turn out several hundred to a thousand parts. In die work, results as a rule are unpredictable, and standards cannot be set due to lack of experience.

Only experience, coupled with the results of future plastics materials development can decide the ultimate part plastics will play in the industrial tooling picture.

Jigs and Fixtures

Assembly, welding, locating, holding and checking fixtures of plastics are light-weight, can be constructed rapidly to close dimensional tolerances, and are dimensionally stable enough for most fixture applications. The methods of fabrication make it possible to hold close tolerances with little, if any, trimming or finishing.

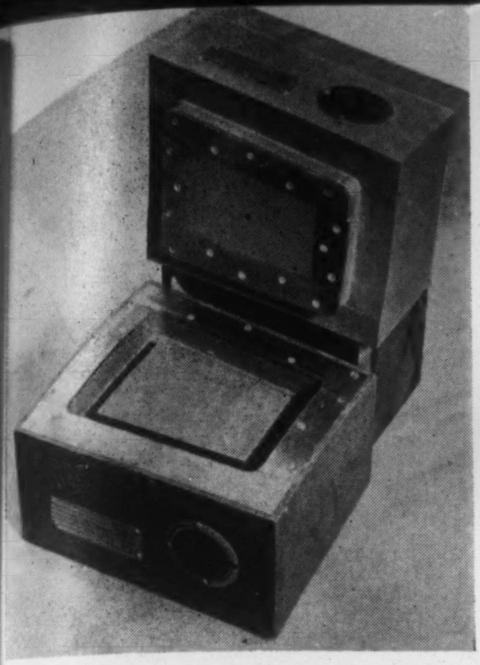
Epoxies are the most widely used resins for laminated jigs and fixtures where dimensional accuracy is critical. They have a high degree of dimensional stability and toughness with low shrinkage, and they can be easily laminated with glass cloth. Their high adhesion is advantageous for casting in bushings and inserts as well as for laminating with glass.

Polyester resins, which cost approximately 75% less than epoxies, are used for glass-reinforced laminated fixtures in instances where high dimensional accuracy is not a critical factor. Cast phenolic resins, which cost approximately 50 to 60% less than epoxies, are used in male forms for fixtures and, in some cases, for structural support.

Die Models, Prototypes

Plastics materials offer substantial advantages for die models and prototypes because their ease of duplication permits several die models to be economically produced from the original master (which also may be of plastics). Availability of more than one die model means that several metal dies can be fabricated simultaneously. Also, accurate models of production dies are simultaneously available to the various departments concerned with the production of the part.

This ease of duplication is also advantageous in working with prototype parts during design development. A number of parts of exactly the same configuration as the projected production part can be economically fabricated for use by the various departments concerned. Since



Steel inserts cast into the plastic, form the cutting edge for this epoxy blanking die made by Renaud Plastics, Inc.

the plastics materials can be machined or patched, design changes can be easily incorporated and tested.

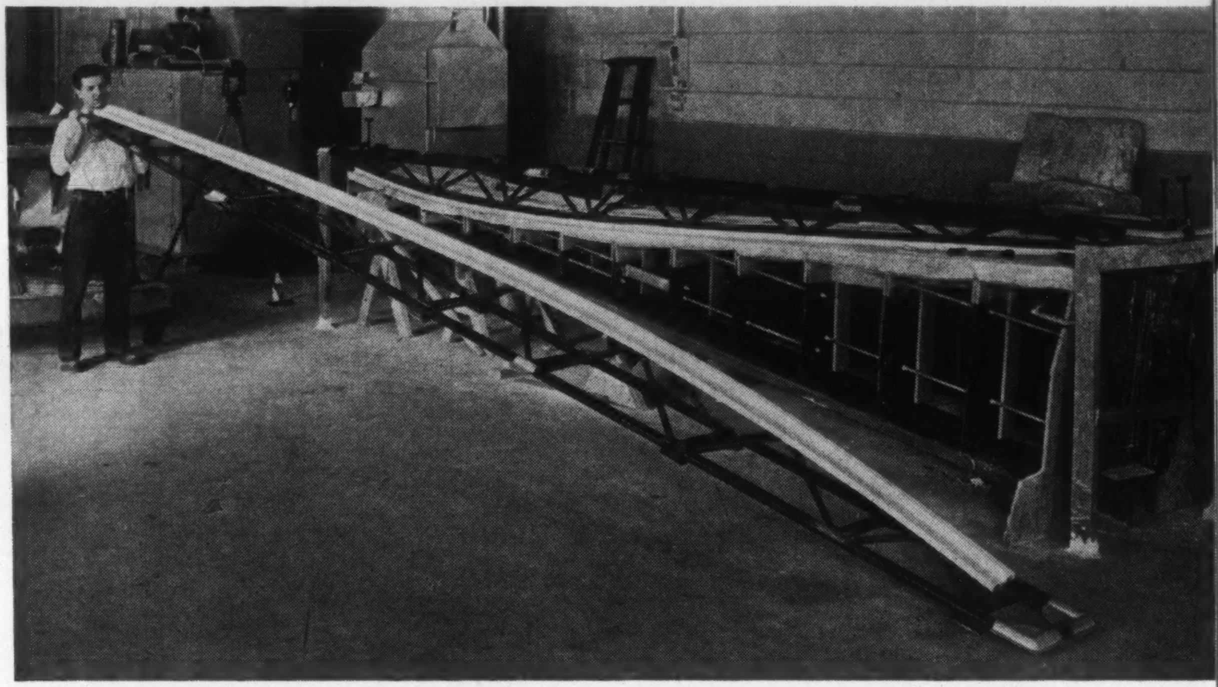
Phenolics are being used extensively for die model and prototype work where the model or part lends itself to a cast shape. Phenolics are cheaper than the epoxies, can be easily cast to shape, and shape is generally more important than physical properties in this kind of tool. Shrinkage of phenolics may cause problems, depending on degree of accuracy required, and resulting castings are relatively brittle and cannot be subjected to rough handling.

Cast epoxy materials can also be used but their cost is two to three times that of phenolics. Incorporation of proper fillers can reduce the exothermic heat generated in large castings to a point where it is not disadvantageous. Prototype parts of relatively thin sections, such as automotive skin panels, are generally made of epoxy-glass or polyester-glass laminates.

Tools for Plastics-Forming

Plastics tools are being used for plastics-forming at moderate temperatures and pressures. The most widespread use is for molds for hand lay-up of reinforced plastics. Plastics molds are also being used in limited production for bag molding and vacuum forming of thermoplastic sheet. Experimental work is being done in an attempt to develop successful plastics matched dies for press forming of laminates; the stumbling block is heat control, made difficult by the low temperature resistance and thermal conductivity of the plastics materials.

With the exception of hand lay-up molds where the easily cast phenolics have an advantage, it is difficult to



Aircraft spar-checking fixture incorporates epoxy-glass laminate face and reinforced plastic tubing for support. (Creative Industries.)

The Plus and Minus of Plastics Tooling

+

Faster tool delivery—Since the plastics tool is cast or laminated to the desired configuration there is little if any of the time-consuming hand barbering and finishing met within metal tooling. It should be remembered, however, that the tool will only be as accurate as the pattern or the mold on which it is formed. With room temperature-curing plastics, annealing or normalizing time sometimes necessary with metal tools is eliminated.

Lower initial tooling costs—Though some tools might be more expensive in plastics than in metal, typically the cost of plastics tools may be expected to average about 50% that of equivalent metal tools. Some will be higher and some much lower.

Light-weight—Reduction in weight of tools allows easier handling in locating and storing. In some cases where cranes are required to handle metal tools, workers can easily handle the same tool in plastics. This factor can be so important as to indicate use of a plastics tool though it might be more expensive than metal.

Ease of duplication—Any number of tools may be made from the same pattern or mold to the same degree of accuracy. Duplicate die models can be easily and cheaply produced to multiply number of metal dies which can be made at the same time.

Ease of repair and revision—Due to workability of plastics materials tools can be easily repaired when damaged or revised to incorporate design changes.

−

Plastics do not have the properties of metals—Though they are lighter, have better corrosion resistance and are more easily formed, plastics do not have the strength, durability, temperature resistance and dimensional stability of metal. They should be used where the properties of the metal are superfluous and the properties of the plastics adequate.

A mold is required to form the material—Plastics must be cast or laid up against a form, mold, part or a fixture. This desired shape whether it be plaster, wood, plastic or a production part must be available and must possess the same degree of accuracy desired in the finished tool.

Health precautions must be taken—Many of the tooling plastics are activated by catalysts which present health problems unless proper precautions are taken in the tool-making shop.

say which materials should be used for which tools. The material for each tool must be selected on the basis of the temperatures, pressures and production quantities necessary. Plastics molds have not been in use long enough to provide the data needed to establish precise ranges within which each material operates effectively.

Currently, however, cast phenolics are being used most widely for plastics-forming molds because they can be easily cast and have relatively good high-temperature strength. Since the forming of reinforced plastics and thermoplastic sheet employs temperatures up to 325 F, care must be taken that these temperatures do not exceed those the tooling plastic can withstand. The life of a phenolic mold is limited somewhat at elevated temperatures by the condensation water remaining in the material after cure. Though the curing heat drives off most of the water, extended use at elevated temperatures continues the drying process and eventually results in cracking and breaking down of the mold.

Plastic Stretch-Form dies have become widely accepted in the aircraft industry. This one, shown at Boeing Airplane Co's Wichita Div., has an epoxy-glass laminate face with hydrostone core on a steel backing plate.

Polyester laminating resins are available with resistance to temperatures up to 500 F. Forming pressures must be low, however, and production is limited by low resistance of tool material to thermal cycling.

The use of epoxy resins for molds is limited by their comparatively low heat resistance. However, one fabricator has found epoxies to be the most successful where curing is carried out at 150 F for a longer period of time. Thermal cracking of cast dies and elevated temperature creep seem to limit widespread application of these materials in plastics-forming tools at this time.

General Properties of Main Tooling Plastics[1]

(Formed at Contact Pressures)

	Epoxies (Room Temp Cure)		Phenolics (Bake Cure)	Polyesters (Oven Post Cure)
	Unsupported[2]	Glass Laminate	Cast	Glass Laminate
Compressive Strength, psi	18–22,000	40–45,000	10–13,000	24–34,000
Tensile Strength, psi	10–12,000	20–44,000	3–6000	25–30,000
Flexural Strength, psi	18–20,000	36–40,000	8–13,000	35–45,000
Impact Strength, ft-lb/in. notch	0.5–1.5	15–20	0.35	18–23
Hardness, Rockwell M	100–125	100–125	80–120	100–115
Shrinkage from Mold Dimensions, in./in.	0.0002–0.0004	Negligible	0.0025–0.0005[3]	0.06–0.08[3]
Heat Resistance (Continuous), F, max	180	180	300[5]	250
Heat Resistance (Short Periods), F, max	300	300	400	—
Thermal Conductivity, Btu/hr/ft/°F	0.12–2.25[4]	0.12	0.9	—
Thermal Coefficient of Linear Expansion, in./in./°F	37×10^{-7}	37×10^{-7}	18×10^{-6}	—
Effect of Acids	None except strong oxidizing acids	Same	Same	Same
Effect of Weak Alkalies	None	None	None	Decomposes
Effect of Strong Alkalies	Slight	Slight	Decomposes	Decomposes

NOTES:

[1] *This table is set up to indicate the general range of properties which can be expected from the materials. Each manufacturer supplies a variety of resins and formulation, and the fabrication of each tool will produce varying properties depending on the resin formulation and the type and amount of glass cloth used. These values are considered optimum for average use.*

[2] *Cast epoxy resins are available with properties similar to laminating resins.*

[3] *Shrinkage can be reduced to some extent by filler materials.*

[4] *Thermal conductivity of laminating resins is 0.12. That of cast resins, through the use of metallic fillers, can be brought to 2.25.*

[5] *This value is for cast asbestos-filled resins.*

Tools for Metal-Forming

The major factor presently limiting the use of plastics for metal-forming tools is lack of experience. As in the case of plastics-forming tools, time has not allowed the accumulation of enough data to establish standards and predict dependable results. Certain types of tools have proven to be advantageous for specific configurations and service conditions and are now in regular production use. Data accumulated from these projects prove that plastics metal-forming tools can provide substantial advantages. But accurate predictions of tool life, gage and type of material that can be formed, and draw characteristics possible cannot be made at this stage in the growth of the industry.

Today the stretch-form die is the most widely accepted plastics tool for metal forming. Many companies in the aircraft industry have gone over to plastics completely for stretch-form dies used in forming both aluminum and stainless steel. The aircraft industry, more than any other, has a natural place for plastics tooling, since frequent modifications and design changes result in a preponderance of short production runs. Matched draw dies, Hydropress and Hydroform punches, bending forms, hammer forms, spinning forms and drop hammer dies are also being made of plastics.

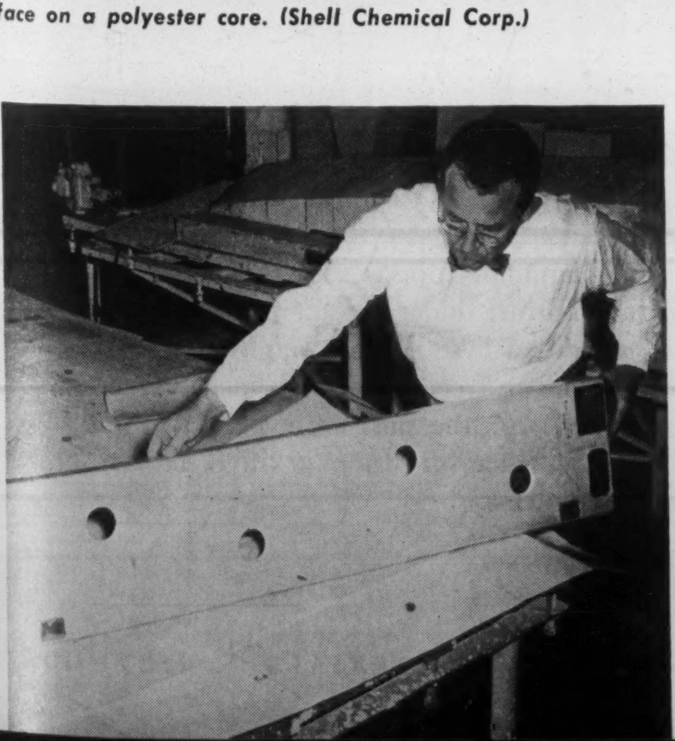
At the present time, there is a definite trend toward epoxies for metal-forming tools. Increasing use of epoxies is due primarily to their low shrinkage, superior strength and dimensional stability, ease of lamination with glass, room-temperature cure characteristics and high adhesive qualities which allow inserts to be cast-in easily. Also, a wide variety of fillers can be used in modifying the resin formulation to gain specific properties. Epoxy resins are being used chiefly in glass-laminated faces of tools, backed by cores of cast epoxy, cast phenolic, cast iron and a variety of other materials. A resilient epoxy formulation is also being used in a cast face on Kirksite for drop hammer work.

Phenolics are also being used for die work, and here there is a marked divergence of opinion. The higher physical properties of epoxy materials cannot be denied. However, they do have a lower heat distortion point than phenolics, and proponents of phenolics claim their material can withstand the molecular and frictional heat generated by metal-working better than epoxies. This heat, they say, results in galling of the surface of epoxy dies and flowing of the detail of the configuration. Phenolics and foamed phenolics are also being used as core materials for dies where compression requirements do not permit use of cast epoxies or other materials.

Ethyl cellulose, though not a new material, has been recently modified and developed to meet the need for a resilient die for drop hammer work. It is a thermoplastic material, which allows melting and recovery of the cured resin. Several aircraft companies have reported successful work, but the future of the material for this application will depend on the results of careful evaluation which can be made only on the basis of experience.

An important question mark in the use of plastics for metal-forming tools is the heat generated by working of the metal. How much heat is generated? And is it sufficient to affect the plastics tool? No one in the field seems to know the answers to these questions. No figures are available on the amount of heat generated by molecular action and friction in various types of metal forming. Some production men claim drawn parts come from the press too hot to handle; others claim little, if any, heat is generated. Some fabricators using the same lubricants used with steel dies, claim the heat problem is negligible. The amount of heat generated depends on the gage and type of material being formed, the configuration of the part, and rate of production. Here again, experience has not yet provided enough data to set standards and specifications.

This restrike die for automotive shields developed by Kish Plastic Products utilizes an epoxy face on a polyester core. (Shell Chemical Corp.)



Dimensional accuracy of plastics tools is illustrated by this master gage made of epoxy-glass laminate which is held dimensionally accurate within 0.001 in. over-all. (Boeing Airplane Co., Wichita Div.)

Future Resin Developments

The price of epoxies is coming down. Already there have been reductions in the prices of the basic resins, and these are being reflected in the prices of the formulations from suppliers.

One of the main directions in development of epoxy resins is toward raising the heat resistance. At present the highest heat distortion point for room temperature-curing epoxies is 180 to 200 F. By oven-curing the materials, heat distortion points of 300-350 F can be attained. According to resin suppliers, room temperature-curing resins now in developmental stages withstand temperatures of 350-400 F. The proof of these resins will be in the using.

Another avenue for development is in the direction of harder surfaces for the cured epoxy resin. Use of fillers such as carbides can impart a high degree of abrasion resistance to the surface, but the essential hardness of the resin remains the same.

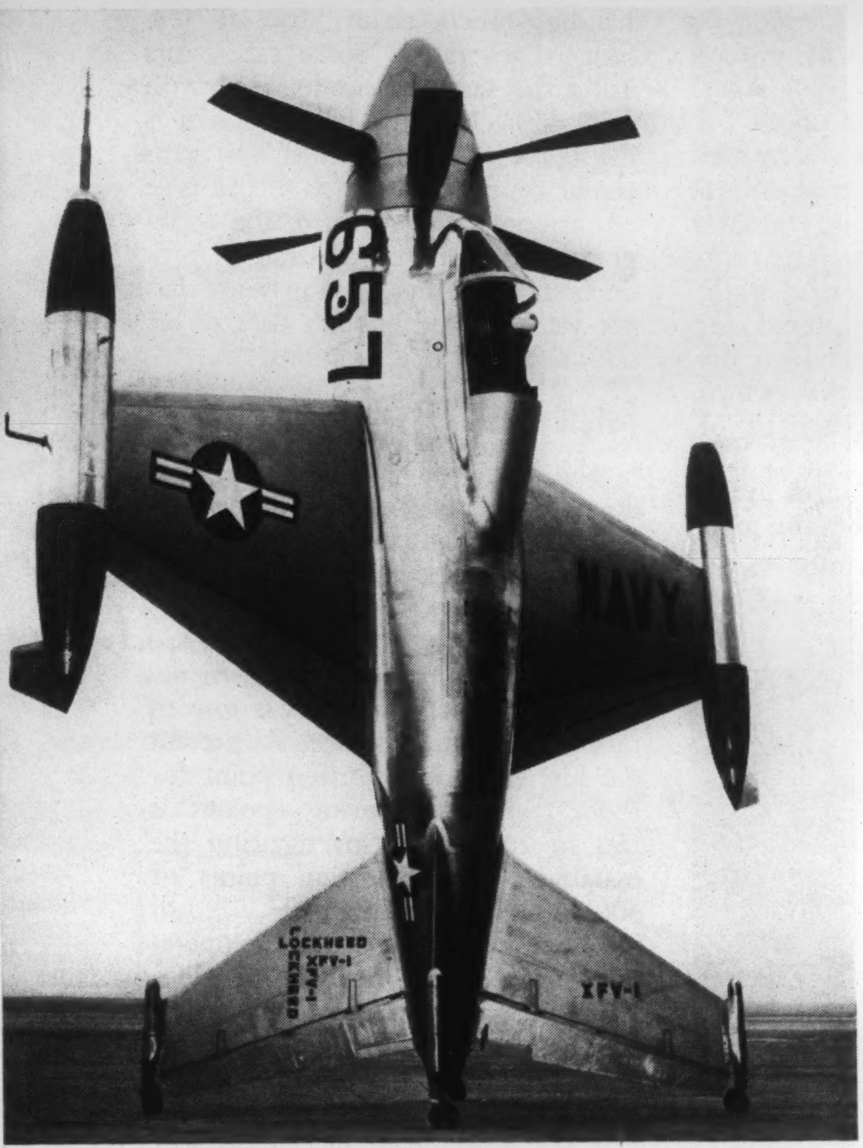
The main problem deterring the use of phenolics for laminates is lack of consistent adhesion between the resin and the glass fibers. Various sizing materials have been tried, but as yet none have been found to be completely satisfactory for low pressure laminated tooling applications.

The need for an oven-bake cure is an important disadvantage of phenolics. Room temperature-curing phenolics are available, but from all reports there is a sacrifice of physical properties and an increased degree of shrinkage due to the larger amounts of accelerator used.

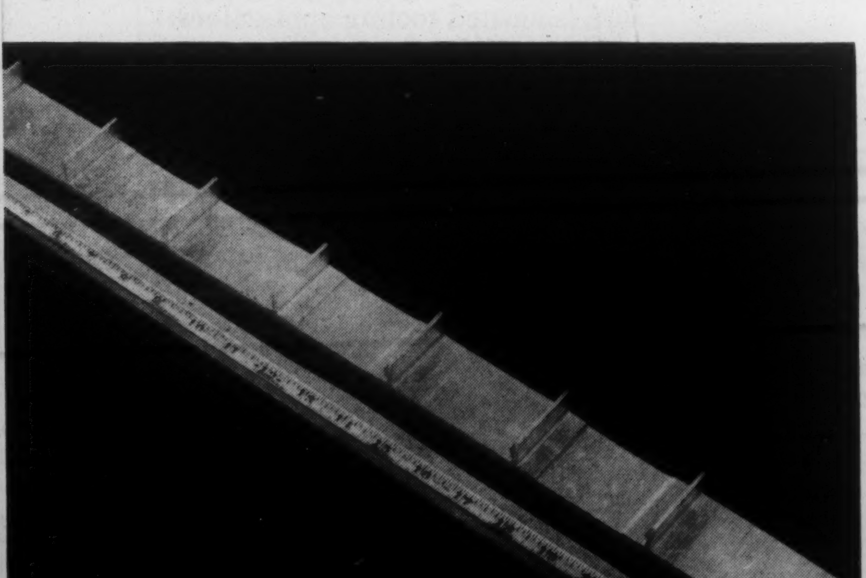
The second article to appear next month will deal with fabrication of the tools, materials formed with them and some developmental applications for plastics in tooling.

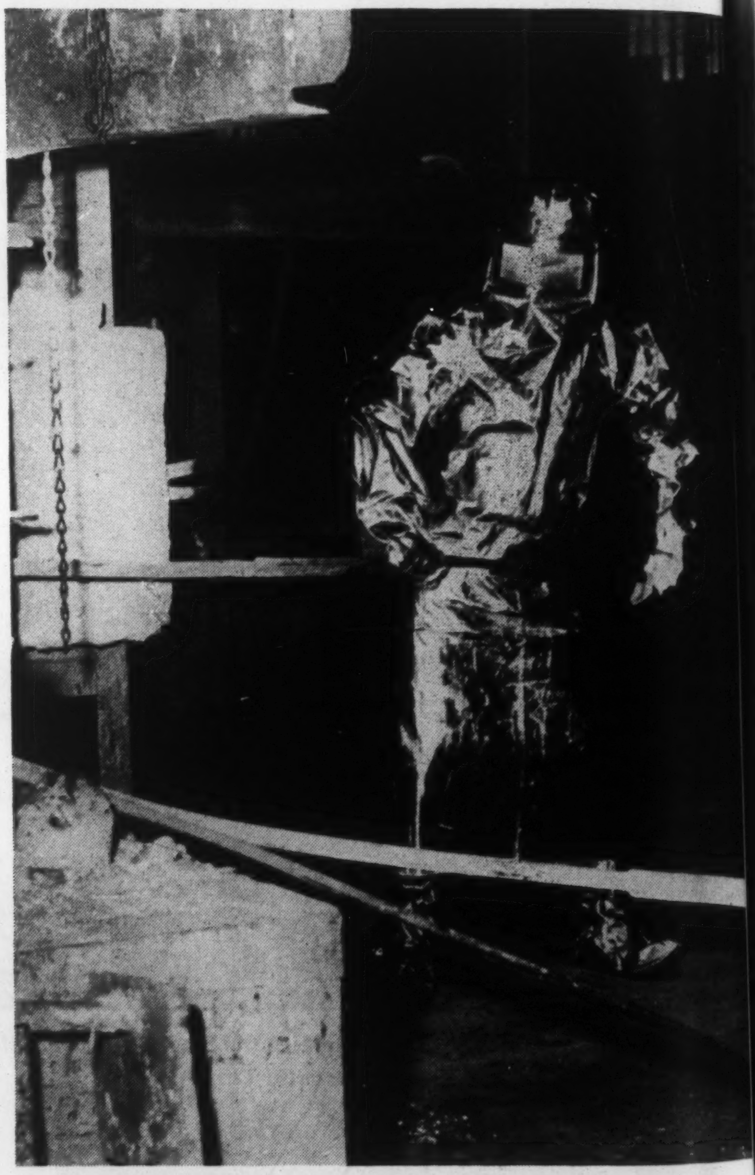
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .

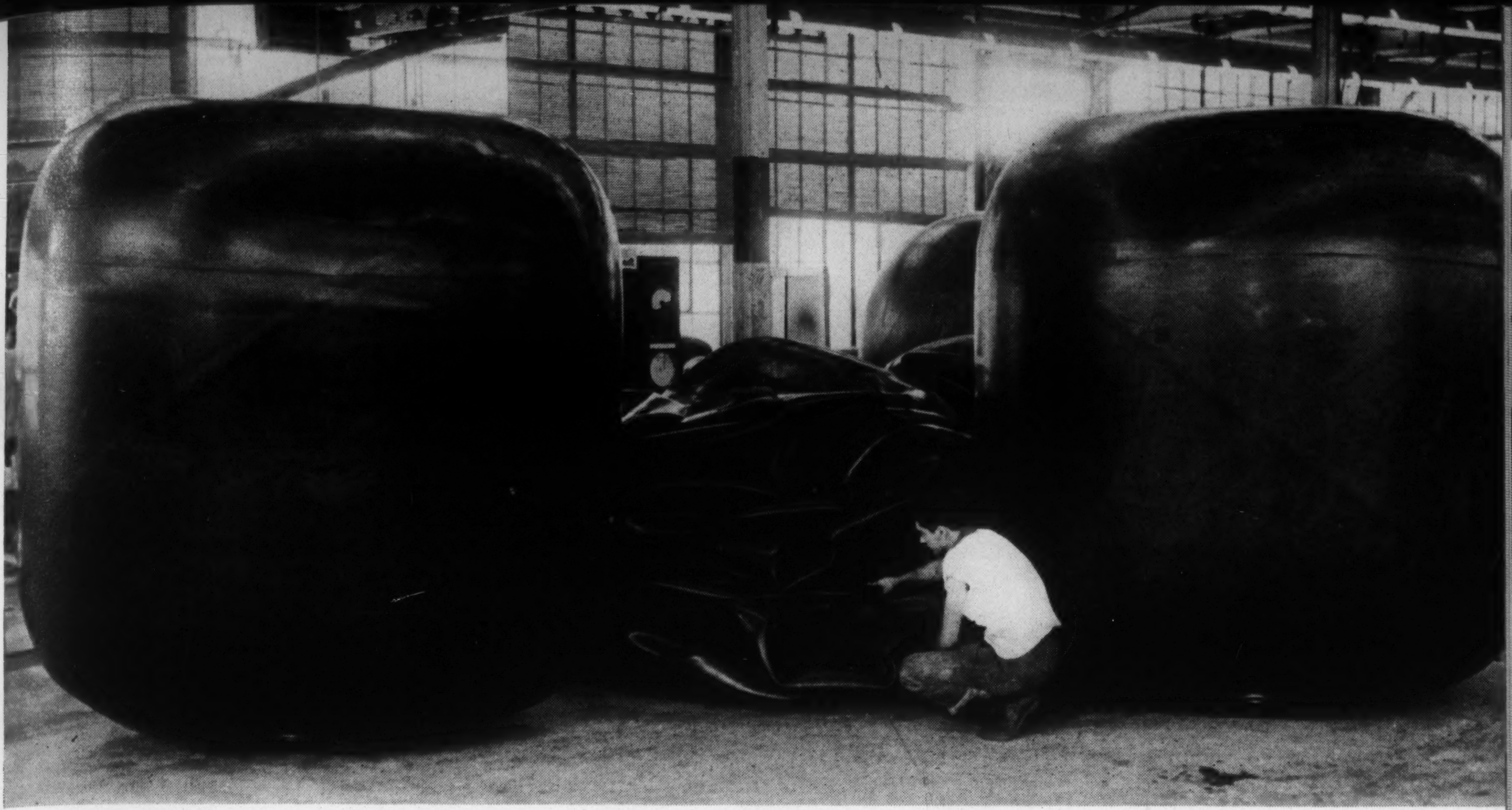


Aluminum Extrusions for VTO Fighter Integrally stiffened 24-in.-wide wing panels for Lockheed's XFV-1 vertical takeoff fighter plane are being extruded by Harvey Aluminum. Use of the aluminum panels results in a 7.5% reduction in wing weight and a 5% reduction in tail weight. According to the aircraft company, substantial savings in machining and fabricating costs and greater strengths are realized through the use of the wide extruded panels. The old method of fabrication involved machining a thick piece of aluminum plate to specifications and reinforcing with riveted angles.

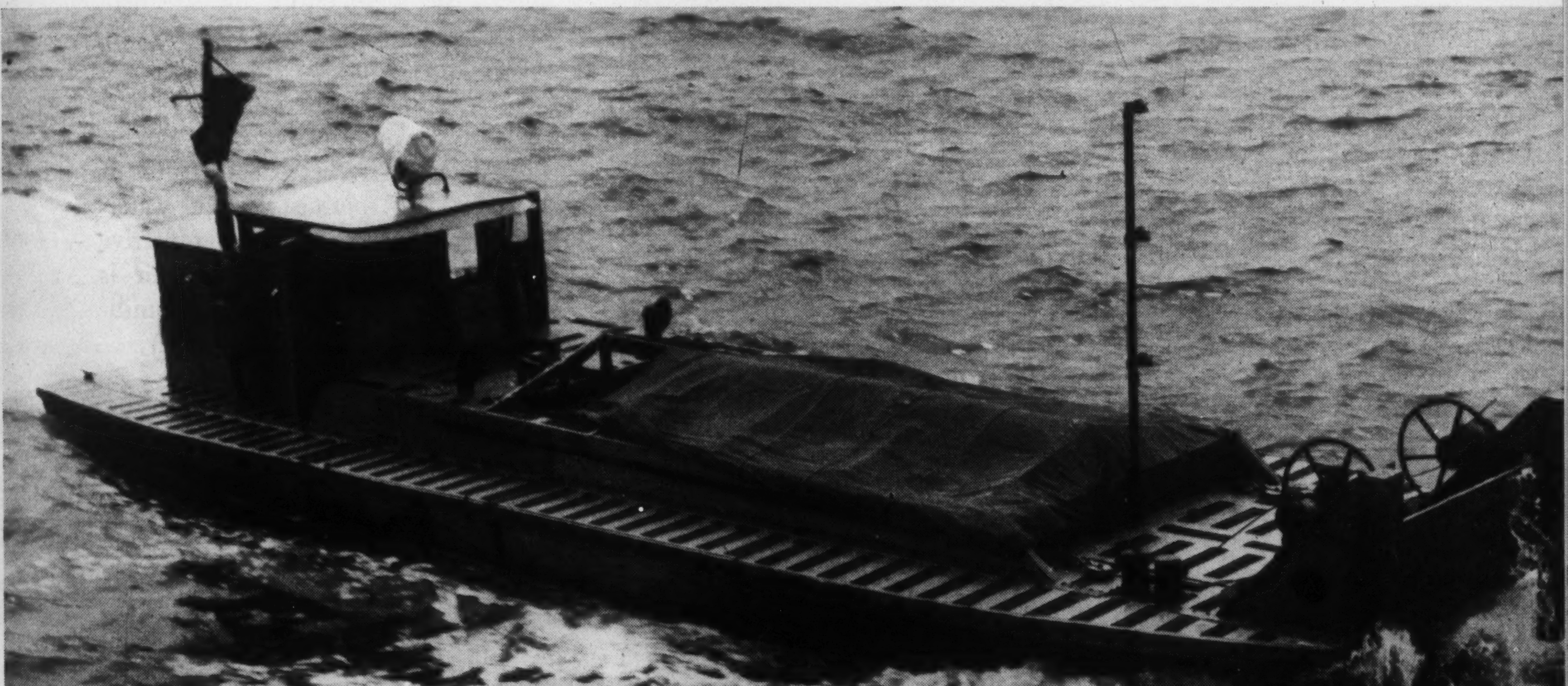




Aluminum Suit Guards Against Heat This suit, made of a flame resistant fabric fused to metallic layers which have been topped with specially treated aluminum foil, is said to keep body temperatures normal under radiant heat up to 2500 F. The suit, called Fyre-Armor, weighs 5 to 10 lb and allows complete freedom of movement. Developed by Far-Ex Corp., the suits are expected to find use in industry wherever flame or high radiant heat present problems.

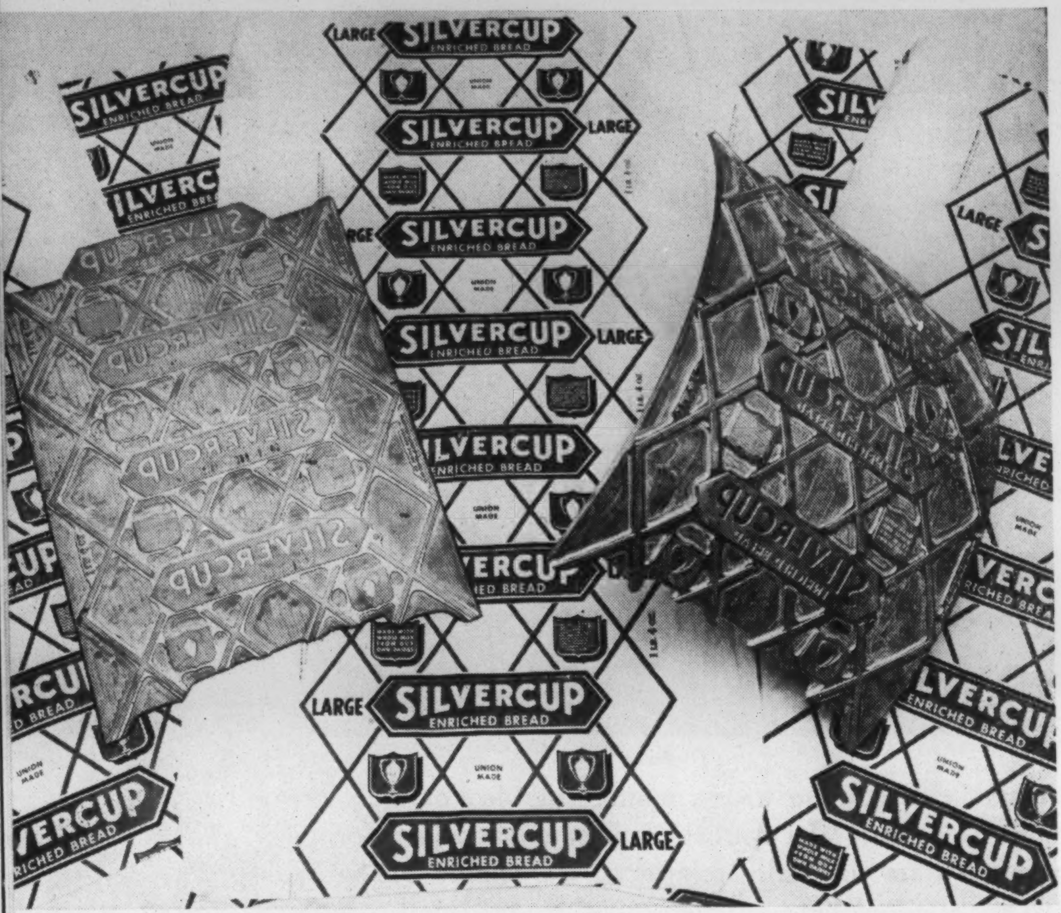


Not Jumbo Balloons These rubber and fabric containers represent a new way of handling bulk shipment of granular and powdered substances. Stacked at the center are 12 collapsed containers between two filled ones. Developed by U. S. Rubber Co., the Seald-Bins are built like a tire with a number of plies of high strength cord fabric and synthetic rubber molded into one piece. They are internally reinforced by flexible lifting cables. Pictured here are the 2500-gal containers. Other sizes are available.



Plastics Barge This shallow-draft, flat-bottom plastics barge has been designed for use on shallow inland waterways overseas. Weighing only 10.2 tons, the craft can transport 5 tons of dry cargo while drawing only 21 in. of water. The plastics construction is expected to reduce maintenance, and hull damage can be repaired easily without costly shipyard lay-ups.

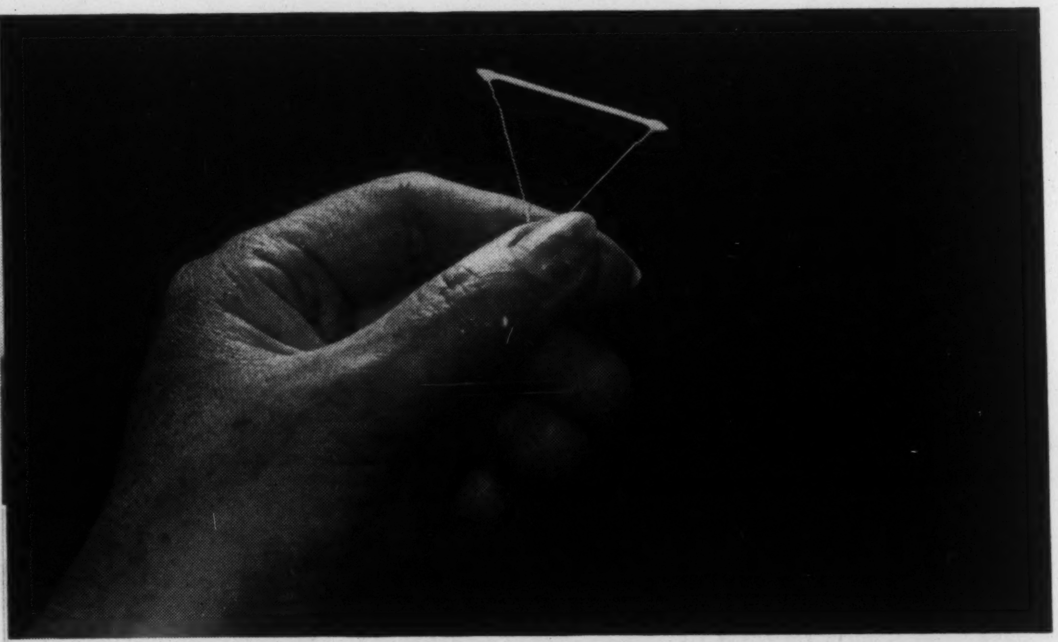
The 50-ft barge is constructed of 15 sections for ease of shipping, and is self-propelled by two 165-hp GM diesel engines. It was designed by W. R. Chance & Assoc. along with the Transportation Research and Development Command of the Army Transportation Corps.



Magnesium Printing Plates

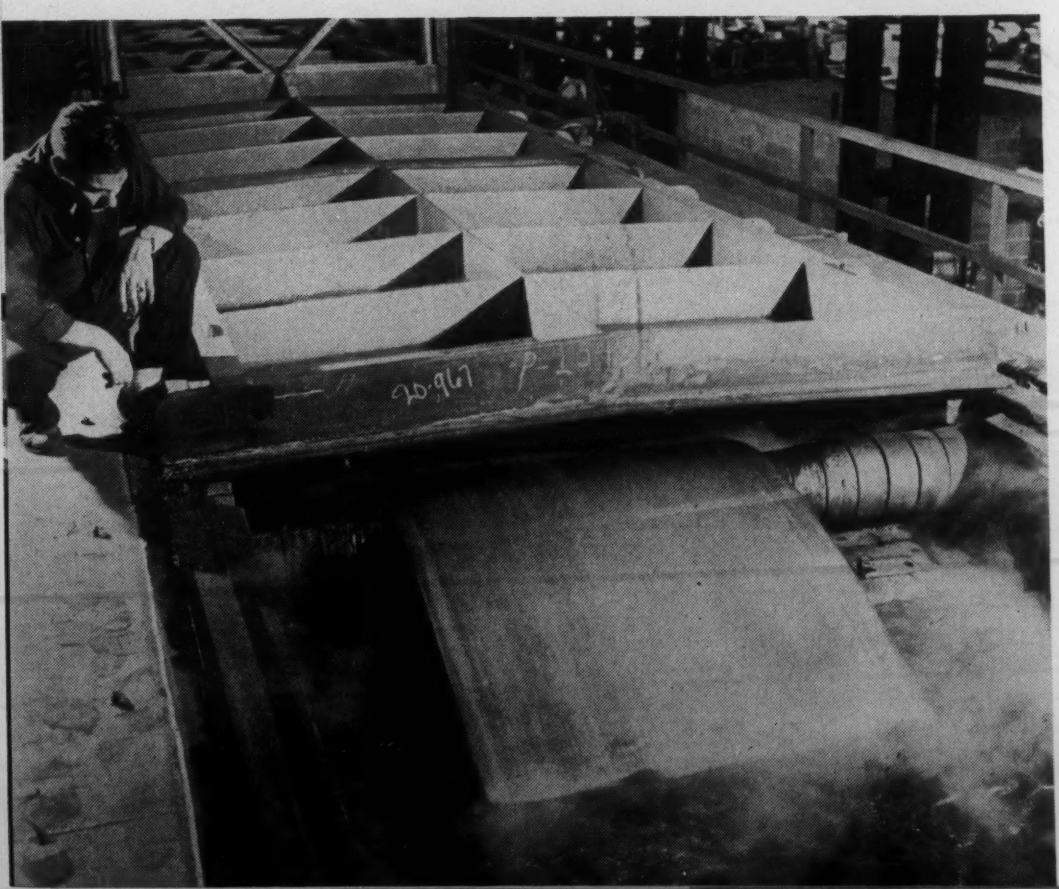
Magnesium provides many advantages for the photoengraving industry due to its fast etching characteristics, its light weight and its price advantage over copper. Recently a new fast-etching process for magnesium has been developed by Dow Chemical Co. which is said to result in time savings of several hundred per cent in comparison with zinc or copper.

Developments by Brooks and Perkins, Inc., now allow the etching and routing of magnesium plate (which is held in thickness to tolerances below 0.0005 in.) prior to curving the plate to fit rotary presses. Etching and routing a plate while in the flat condition results in obvious fabrication advantages. Shown here in two stages is a magnesium plate for printing bread wrappers. At left is the flat plate after etching and routing. At right is the curved plate ready for the press.



Tiny Thermistor of Metal Oxide

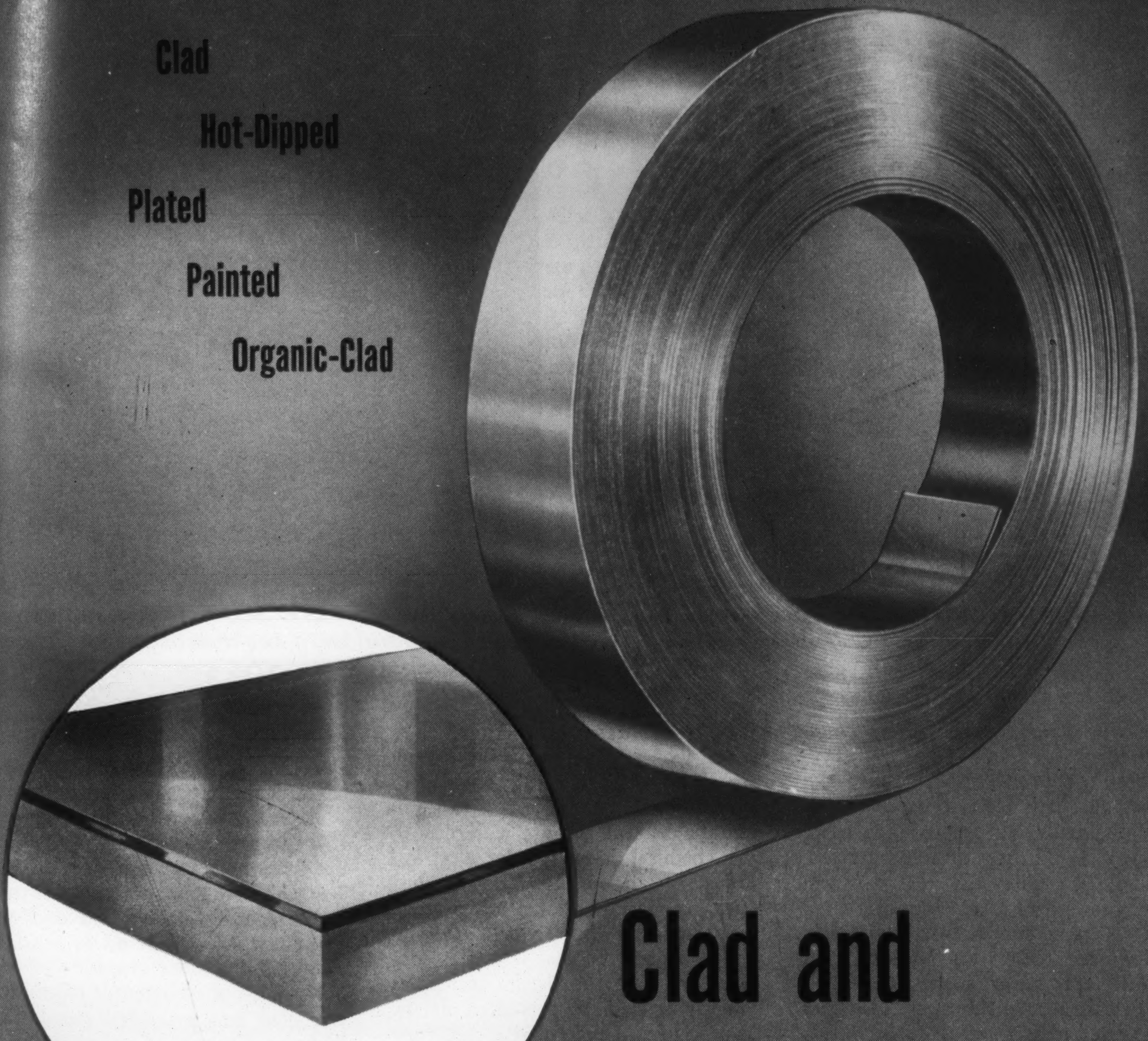
Designed for temperature measurement and control in the range of –75 to 100 F this toothpick-like rod with radial leads is composed of metal oxides and manufactured by a ceramic process. Made by Ferroxcube Corp. of America, the thermistors are waterproofed and coated with a reflective coating. Performance of the unit is said to meet the requirements of military specs MIL-T-12284A (Sig.C).



Rubber Aids Pickling of Steel

This sheet of steel is passing from one pickling tank to another over 21 midget rubber rolls on a common, stationary shaft. The sectional roll is said to prevent scratching of the metal, reduce maintenance costs, simplify roll warehousing and to cost 30% less than conventional skid blocks. It was developed by the B. F. Goodrich Co. and is installed at Pittsburgh Steel Co.

Clad
Hot-Dipped
Plated
Painted
Organic-Clad



Clad and Precoated Metals

by **JOHN B. CAMPBELL**, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 111

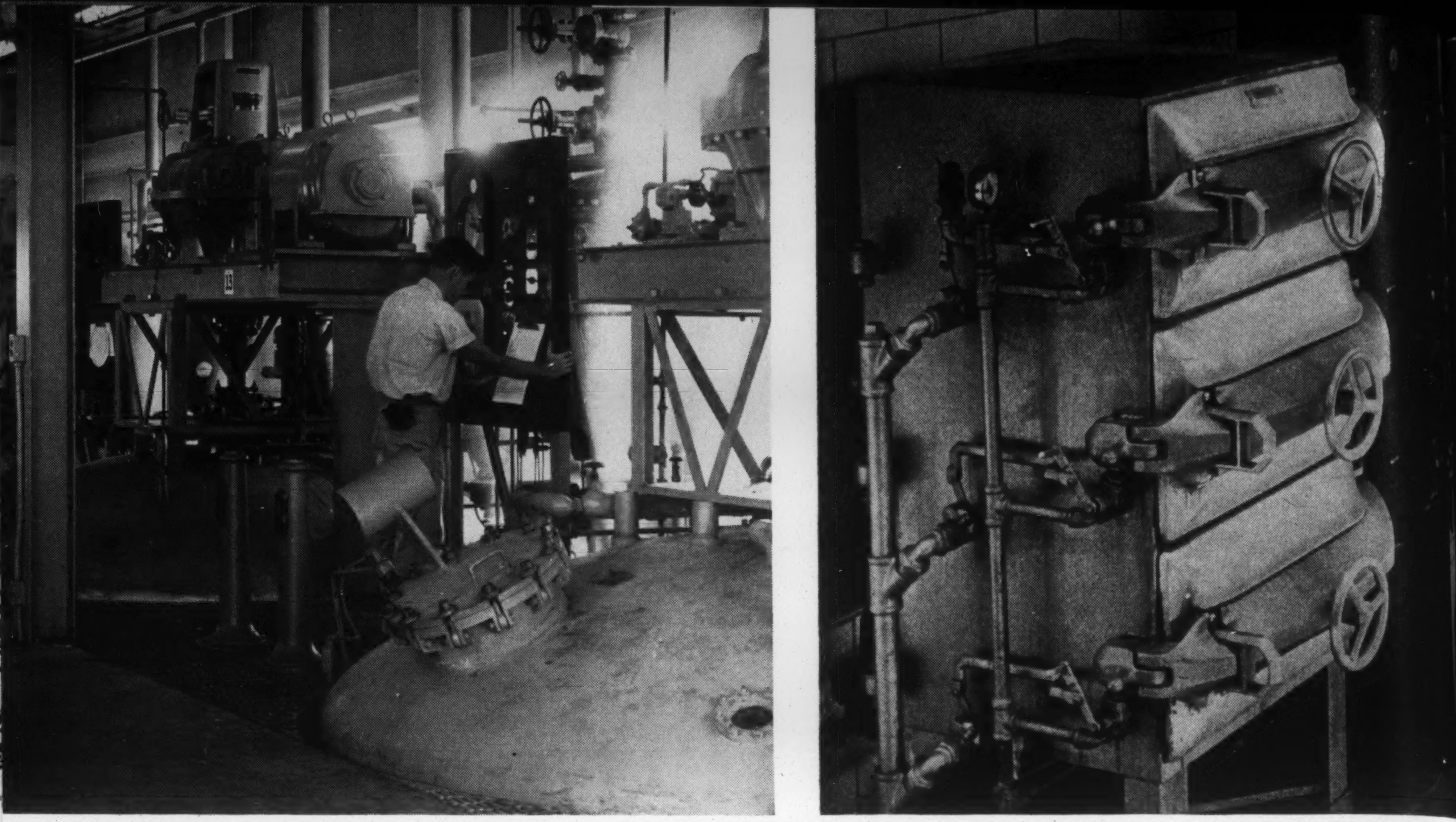
This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

DECEMBER 1954

Metal laminates, in the form of plate, sheet, strip, wire and tubing, are widely used in industry today. The second layer may be metallic or organic, thick or thin, continuous or not so continuous. It may provide an attractive appearance, corrosion resistance or one of many other surface properties; or it may join with the base metal to provide special heat transfer, expansion or other important properties.

This manual is the first to cover all of these materials. An extensive table describes the specific clad and precoated metals in most common use. Other sections are:

- *Types of Materials*
- *Advantages and Applications*
- *Properties, Fabrication and Cost*



STAINLESS-CLAD STEEL PLATE *is used in the two-story tanks for handling drugs in Wyeth's West Chester, Pa. plant, and in the steam food cooker made by Cleveland Range Co. (Lukens Steel Corp.; Ingersoll Steel Div. of Borg-Warner Corp.)*

Two materials are often better than one.

And, where two materials *are* better than one, it is often cheaper to buy them already bonded to each other than to bond them after fabrication.

Together, these two realities form the concept of clad and precoated metals—a concept that is widely recognized today, yet promises still greater application in the future.

In this article, the term "clad and precoated metals" refers to *all metals that are produced in some laminated form,* even though part of the laminate may be nonmetallic. A host of different terms has been applied to all or part of this broad category of materials; some of the most familiar are "bimetals", "clad metals", "combined metals", "composite metals", "metal laminates", "precoated metals", "prefinished metals", "prepainted metals" and "preplated metals".

Never before have all of these different types of materials been discussed together in print. There are three good reasons. First, they have vastly different properties. Second, they are produced by entirely different manufacturers. Third and perhaps most important, they are, to a great extent, used by entirely different industries.

If these materials do not have properties, manufacture, or uses in common, why, then, lump them together at all? Simply because they *do* have in common a concept of design that is both important and useful to engineers who do not wish or cannot afford to be permanently chained to a traditional material. It is an important concept because it applies to the chemical industry, the electrical industry, the consumer goods industries, in fact virtually all product manufacturing industries. It is a useful concept because it invites consideration of the basic principles underlying clad and precoated metals. Most clad and precoated metals now in existence have been developed to meet specific needs in specific industries. A knowledge of principles is essential, therefore, not only to intelligent selection and use of clad and precoated metals now in existence, but also to the development of new clad and precoated metals to meet new needs, perhaps even in new industries.

This article develops the concept of clad and precoated metals primarily as follows:

1. An outline of the different types of clad and precoated metals.
2. A discussion of the advantages that may be realized with these different types and with specific materials.
3. A discussion of factors involving properties, fabrication and cost that must be considered in selecting clad and precoated metals.
4. A list of common or representative clad and precoated metals that includes important characteristics, typical applications and some sources of supply.

Neither the purpose nor the length of this article permits the inclusion of details on the properties, design or fabrication of individual clad and precoated metals. For the same reasons, this article assumes a general knowledge of the characteristics of the monolithic materials that make up clad and precoated metals.

Types of Materials

Clad and precoated metals may be classified in several different ways. One is by the nature of the face material, which may be metallic, organic or vitreous.

This article will consider only metal-metal and metal-organic combinations. In the form of precoated sheet, porcelain enamel is more likely to be considered a monolithic material than a laminate. Moreover, at present, porcelain-enameled iron and aluminum sheet are capable of relatively little postforming compared to most other clad and precoated metals.

Metal-Metal

By far the bulk of clad and precoated metals consists of combinations of two (or, in some cases, three) metals. Except for carbon and low alloy steels, which usually serve only as base metals, the most important metals are aluminum, copper, chromium, gold, lead, nickel, platinum, silver, tin, and zinc plus many alloys, especially stainless steel and alloys of aluminum, copper, gold, lead and nickel. The characteristics of these metallic combinations depend to a great extent on how they are made. The three general methods are electroplating, hot dipping and cladding.

Pre-Plated Metals—Precoated metals made by electroplating have a face metal that may be 0.01 to 1 mil thick, depending on the particular material. In most cases, coating thickness does not exceed about 0.2 mil.

With the exception of brass, coatings applied by electroplating are essentially pure metals. The most common are copper, zinc or aluminum. Sometimes a preplated metal is supplied with two or more electoplates, almost invariably copper-nickel or copper-nickel-chromium.

Flat products of some materials may be preplated on both sides. Some preplated metals can also be supplied with special mechanical finishes. The surface may be bright, satin or alternately striped bright and satin. It may also be crimped or corrugated in rectangular or diagonal patterns. Such finishes are often protected against damage during shipping or fabrication by means of strippable plastic coatings.

Preplated metals are ordinarily furnished as sheet or strip in coils, and may be annealed or temper rolled. Probably the best-known examples of preplated metals are electrolytic tinplate, used mostly for tin cans, and electro-galvanized steel, widely used for roofing as well as many industrial products.

Pre-Hot Dipped Metals—Precoated metals made by hot dipping have a face metal that may be 0.07 to 2 or more mils thick, again depending on the particular material. Hot dip coatings are generally thicker but not as uniform as electroplated coatings. Also, they are not as pure as electroplated coatings, and some coatings, especially those of lead, are actually alloys.

In addition to lead, the most common hot dip coatings are aluminum, tin, zinc and a high lead alloy called "terne". The base metal for pre-hot dipped combinations is usually low-carbon steel, but copper is also used. Flat products are often precoated on both sides.

Pre-hot dipped metals are ordinarily supplied in the form of sheet, strip or wire. Tinplate and galvanized steel, which are also produced by electroplating, are probably the most familiar examples of pre-hot dipped metals.

Clad Metals—Clad metals are made by applying one metal to the other in one of a variety of ways, followed by rolling (plate, sheet, strip) or drawing (tubing, wire) of the combination to produce a material generally much more strongly bonded than a precoated metal. The most common methods of applying one metal to the other are direct sandwich rolling, hot pressing, casting and brazing. Swaging, casting, extrusion and sometimes plating are used for tubing and wire. A new method of cladding is expected to be announced shortly. It involves the use of brazing material and pressure applied by creating a vacuum between the surfaces to be bonded.

The "face" of a clad metal is usually considerably thicker than that of a precoated metal. A range of 5 to 20% of the thickness of the combination is most common, although the proportion may be as high as 90% in some special materials. Actual face metal thickness may range from almost one foot for lead-clad steel to as little as one mil in some special strip applications.

Clad metals are furnished as plate, sheet, strip, tubing and wire, and a great variety of materials is available. Clad plates include steel faced with lead, copper, nickel, nickel alloys and stainless steel. Sheet and strip include the alclads, aluminum-clad steel, copper-clad aluminum, stainless-clad copper and many different combinations of copper and copper alloys, nickel and nickel alloys, silver, gold and platinum. Other clad metals include alclad tubing, lead-clad copper tubing, copper-clad steel wire and nickel-clad copper wire.

Some clad materials have a thin layer of a third metal interposed between the two principal layers. The object is to prevent the formation of an interfacial alloy layer that is brittle or may become brittle as a result of normal heat treatment. A good example is ferritic stainless-clad steel plate in which a thin layer of electrolytic nickel serves to block the carbon in the steel from diffusing into the stainless and combining with the chromium. Copper- and monel-clad steel plates also have a nickel interlayer.

Clad sheet and strip are sometimes furnished with a bright finish which is protected during shipment and storage by a paper interleaving. The face metal of clad plate is usually protected by a plastic coating, such as chlorinated rubber. Probably the most familiar examples of clad metals are the two metals widely used in jewelry —"gold filled" and "rolled gold plate"—which are actually gold-clad copper or nickel alloys.

Pre-Lined Metals—Another type of metal-metal laminate, competitive with clad plate for many applications but not generally available on the market, is known as "applied liners". Applied liners or pre-lined metals are made by welding one metal to the other. A pre-lined metal is unlike a clad metal in that it is only intermittently bonded instead of continuously bonded. Welding methods include spot or seam welding, welding through the thickness of the lining with the submerged arc, and welding plugs into holes cut in the sheet.

Applied liners are not economical in thicknesses below ¼ in. and linings usually range from 1/16 to 3/16 in. in thickness. The most common lining metals are stainless steels, monel and the Hastelloys. The base metal is usually a mild steel. Applied liners are made and used only by fabricators of process industries equipment, such as Babcock & Wilcox Co., Chicago Bridge & Iron Co. and A. O. Smith Corp.

Metal-Organic

There are two general types of metal-organic laminates: prepainted metals and organic-clad metals.

Prepainted Metals — Prepainted metals have a face consisting of a more or less conventional organic finish that has been spread on and dried or baked. Thickness of coating can range from 0.1 to 2 mils, depending upon customer requirements, but the usual thickness is ½ to 1 mil. For many applications, including almost any that involve forming, prepainted metals are supplied with a phosphate conversion coating beneath the organic finish to provide the necessary adherence.

Prepainted metals are available with a great variety of organic finishes, but the most common are cellulose lacquers, alkyd baked enamels and vinyl lacquers or enamels. These types are available in many different colors, although cellulose lacquers, especially, are often supplied clear. The most common base metal is low-carbon steel, but aluminum, brass, zinc, galvanized steel and tinplate are also used. Prepainted metals are almost invariably supplied as coils of strip. The slats of venetian blinds are often made from prepainted (alkyd) steel or aluminum strip.

Organic-Clad Metals — Organic-clad metals have a face consisting of a plastic sheet or film that has been bonded to the metal surface by means of adhesive, heat and a greater or lesser amount of pressure. Only one material of this sort is being produced at the present time. The plastic is polyvinyl chloride and it is bonded to steel plate, sheet or strip. The highly chemical-resistant PVC face ranges in thickness from 8 to 30 mils and is available in many colors, as well as leather-grain and other special textures. It is claimed this material can also be produced with an aluminum or magnesium base.

Another organic-clad metal—Mylar-clad steel sheet—is expected to be available before long. The clear polyester film face will range in thickness from 0.5 to 7.5 mils. Other base metals contemplated are brass and tinplate. Mylar-clad steel is expected to be useful in containers for chemicals.

The Table

The table starting on p. 117 lists the clad and precoated metals that are in most common use today.

In addition to the materials comprising the laminate, the table indicates its general method of manufacture, the forms in which it is available and their usual range of thickness, the usual range of thickness of the face material, special finishes available, some typical applications, the principal functions performed by the face material, the basic advantages offered by the material, and some important sources of supply. As an aid in locating a particular combination of materials, the list is arranged according to the identity of the face material. The 12 major groups of face materials are in alphabetical order, and the individual materials within each group are also arranged more or less alphabetically.

This table should be approached with caution. Some strange bedfellows have been created by the arbitrary arrangement described above. It should not be inferred from mere juxtaposition in the table that any two materials are comparable in properties or uses, let alone importance or usefulness. The extent of the differences in properties to be expected from the various types of clad and precoated metals should already be clear from the preceding discussion and will be further underlined in the following sections of this article. Some of these materials are produced by the ton and others by the pound. Some are made continuously and others only to special order. Some are used in many industries and others in only a single industry, perhaps only a single product.

No attempt has been made to provide complete information on available forms of these materials. Not all of the forms listed for a particular material are necessarily available from all of the manufacturers listed. The thickness ranges shown generally represent those most commonly specified and not necessarily the limitations of the manufacturer. Information on maximum widths and lengths has been omitted because of its great variability.

Lengthy as it is, the list does not include all the metal laminates that are being produced today. The clad strip combinations of copper, nickel and precious metal alloys, for example, seem almost countless. Sheet and strip clad with brazing alloys are not listed in the table, although they are discussed elsewhere in this article. Copper-clad stainless strip is reported to be useful not only for brazed assemblies but also for corrosion-resistant gaskets. At least two materials that were of some importance during World War II are not included; they are copper-clad magnesium, which was used as a substitute aircraft battery material when nickel was in short supply, and silver-clad steel, which was used as a substitute for copper-clad steel in electrical applications when copper was short. Other combinations that have been made are calcium-clad nickel, platinum-clad stainless, molybdenum-clad cupro-nickel, molybdenum-clad steel and nickel-clad molybdenum.

Finally, there is no mention of the materials that are still being developed at the present time. Probably the most interesting of these, in addition to Mylar-clad steel, are titanium-clad steel which is expected to be especially useful in submarines and possibly in chemical process equipment, and zirconium-clad steel, which will probably be most useful in atomic reactors and possibly in some high-temperature applications.

Advantages and Applications

The foregoing brief outline of the field suggests both some of the advantages and some of the limitations of clad and precoated metals. But, more specifically, what *are* the jobs that can be done by metal laminates? And what advantages do they offer compared to alternative materials and methods?

From a functional viewpoint, three types of metal laminates can be distinguished:

1. Laminates that are supplied with a primarily decorative face and therefore need little or no finishing after fabrication. These "prefinished" metals may be preplated, prepainted or sometimes organic-clad. Most prepainted metals and many preplated metals are suitable principally as prefinished metals.

2. Laminates with a face that provides one or more important surface properties (other than appearance) and a base metal that makes the laminate cheaper and/or stronger than the equivalent face material alone. Such metals may be pre-hot dipped, clad, or sometimes organic-clad or preplated. Almost all pre-hot dipped metals and a majority of clad metals belong to this category.

3. Laminates which provide special non-surface properties or properties resulting from a reaction between base and face. Such materials are usually clad metals.

The peculiar advantages of these different categories of materials are discussed in more detail below. Specific materials are named, not only as examples, but also in order that this section may serve as a functional guide to the accompanying list of the common clad and precoated metals.

Appearance

Where corrosion is not a serious problem, it is common to apply a relatively thin organic or metallic finish to a fabricated part principally to improve its appearance. If forming operations are not severe, the use of prefinished metals can sometimes

Common Clad and Precoated Metals

Face Metal	Base Metal	Form (incl. common thickness range)	How Made	Face (usual thickness, forms)	Critical Functions, Properties	Typical Applications	Some Important Sources
ALUMINUM AND ITS ALLOYS							
Aluminum	Steel, low-carbon or copper-bearing	Sheet, strip, 0.016–0.112 in.	Hot dipped	0.001 in. on each side (0.50 oz/sq ft)	High heat reflectivity. High-temperature oxidation resistance. Forms refractory iron-aluminum alloy at 1000 F. Strong, low-cost base	Oven door liners, aircraft fire walls, auto mufflers, broiler parts, baffles for space heaters, toaster inner parts, water heater casings, jet engine parts	Armco Steel Corp. (Aluminized Steel)
Aluminum	Steel (ASTM A 122)	Strand, 7-wire, ⅛–⅝ in.	Hot dipped	0.40–1.00 oz/sq ft (Class A)	Atmosphere resistance. Galvanic protection. Strong base. Longer life than zinc-coated steel	Guy wires, span wires, overhead ground wires.	American Chain & Cable Co.
Aluminum (1½% Si)	Steel, low-carbon	Strip, 0.005 in., annealed	Clad by pressing, rolling	10% of thickness on each side	High-temperature oxidation resistance. At 1000 F, forms gray iron-aluminum alloy that gives 85% black body radiation. Cheaper than carbonized nickel or nickel-clad steel. Conserves nickel	Anode plates for electronic receiving tubes	Metals & Controls Corp.
Aluminum (1½% Si) with Ni (330) on other side	Steel, low-carbon	Same as above	Clad by pressing, rolling	Same as above	Same as above, but suitable for higher ambient temperatures	Anode plates for electronic receiving tubes where close tube spacing makes external temperature too high for aluminum	Metals & Controls Corp. (Alnifer)
Aluminum (1100)	Aluminum (2024)	Sheet, 0.016–0.250 in., O or T3	Clad by direct rolling or casting, rolling	2–15% of thickness	Atmosphere resistance. Galvanic protection. Strong base	Military and commercial aircraft frames, cooking utensils, hardware	Aluminum Co. of Amer., Kaiser Aluminum Corp., Reynolds Metals Co.
Aluminum (6053)	Aluminum (2014)	Sheet, 0.015–0.250 in., O, T4 or T6	Clad by direct rolling or casting, rolling	Same as above	Atmosphere resistance. Galvanic protection. Wear resistance. Workable base	Power shovel bails, aircraft fittings, heavy duty forgings.	Same as above
Aluminum (6053)	Aluminum (5056)	Wire, up to ⅜ in. dia.	Clad by casting, drawing	Same as above	Same as above	Insect screening	Same as above
Aluminum (7072)	Aluminum (3003 or 3004)	Sheet, 0.015–0.250 in., temper rolled	Clad by direct rolling or casting, rolling	Same as above	Atmosphere resistance. Galvanic protection. Workable, weldable base	Cooking utensils, gasoline and oil tanks, bus and train trim	Same as above
Aluminum (7072)	Aluminum (3003)	Tube, ⅛–11 in. o. d.	Clad by swaging, drawing	2–15% of thickness on inside	Same as above	Heat exchangers for process industries	Same as above
Aluminum (7072)	Aluminum (7075)	Sheet, 0.020–0.188 in., O or T6	Clad by direct rolling or casting, rolling	2–15% of thickness	Atmosphere resistance. Galvanic protection. High-strength base	Aircraft structural parts	Same as above
COPPER AND ITS ALLOYS							
Brass, copper	Steel, low-carbon	Sheet, strip, 0.008–0.250 in., temper rolled	Electroplated	0.10–0.15 mils on one or both sides. Natural satin or bright. May be striped, crimped, corrugated	Decoration. Atmosphere resistance. Good solderability	Luggage, hardware, costume jewelry, flashlight cases. lamp tubing. chime tubes, cymbals, picture frames, display stands	Amer. Nickeloid Co., Apollo Metal Wks., Pittsburgh Steel Co.
Brass, (70/30 or 85/15)	Steel, low-carbon	Strip, 0.004–0.125 in., temper rolled	Clad by direct rolling	10 or 15% of thickness on one or both sides	Same as above	Cosmetic cases, bed frames, nameplates, gaskets	Amer. Silver Co., Superior Steel Corp. (SuVeneer)
Brass (over Cu)	Steel, low-carbon	Wire, 0.090–0.375 in.	Clad by plating, drawing	½–1 mil (brass only flash)	Decoration. Atmosphere resistance. Cheap, strong base metal. Conserves brass	Curtain rods, indoor television antennas, lamp stands	Kenmore Metals Corp.
Brass, copper	Zinc	Sheet, strip, 0.006–0.125 in.	Electroplated	0.10–0.15 mils on one or both sides. Natural, satin or bright. May be striped, crimped, corrugated	Decoration	Moldings, ornaments, trim, badges, buttons	Amer. Nickeloid Co., Apollo Metal Wks.
Bronze (90/10)	Steel, low-carbon	Strip, 0.004–0.125 in., temper rolled	Clad by direct rolling	10 or 15% of thickness on one or both sides	Decoration. Atmosphere resistance. Cheap, strong base metal. Conserves copper	Ornamental trim, shell cases	Amer. Silver Co., Superior Steel Corp. (SuVeneer)

(table continued on page 119)

eliminate virtually all finishing and provide a net cost saving.

There are two basic reasons why the premium paid for prefinished sheet or strip is often less than the cost of finishing fabricated parts, especially small parts:

1. The cost of handling strip or sheet on a continuous finishing line is considerably less than the cost of handling many small parts individually in a conventional finishing operation. Prefinished stock can be made with fewer racks and fixtures, with less materials handling equipment and with much less labor.

2. The amount and therefore the cost of the coating material needed to assure a specified average or minimum thickness of finish is likely to be much less on a continuous finishing line than in a conventional finishing operation. Prefinished stock can be furnished with a uniform coating because its surface is flat and uniform on the continuous finishing line. Formed and plated parts often show build-up, since the plating period must be prolonged enough to allow coverage of the more inaccessible surfaces. Formed and painted parts are often subject, not only to build-up, which results from the tendency of the paint to flow off high points and vertical surfaces, but also overspray.

However, the difference in the initial cost of prefinished stock is not the only premium to be considered. Precautions in handling and fabrication are necessary to avoid damage to the finish. Additional precautions may be necessary to avoid destruction of the bond. The cost of such precautions or of an increased reject rate, though sometimes hard to assess accurately, may offset the natural cost advantages of prefinished metals.

Sometimes the cost of prefinished metals cannot be compared directly with that of conventional finishing operations. Prefinished stock may be preferable even in the face of an unfavorable normal cost comparison if it means that an additional capital investment of dubious future value can be avoided. Furthermore, some prefinished metals make possible special designs from inexpensive products that would not ordinarily be considered economically feasible. Prepainted strip can be supplied with the two sides of different colors. Preplated strip can be supplied not only with a different metal on each side but with complex and attractive mechanical finishes as well. And vinyl-clad metal can be supplied not only in different colors and surface textures but in considerably greater thicknesses than conventional metal finishes.

When it is not possible to protect the surface of a preplated metal from damage during fabrication, copper-flashed steel strip is sometimes used for products to be nickel- or chromium-plated. Similarly, nickel-plated steel, zinc, copper, brass and aluminum may be useful for products to be chromium-plated.

Generally, the potential advantages of prefinished metals are most fully realized when they are fed to automatic machines in the form of coiled strip. Although some of these materials, notably the vinyl-lacquered and vinyl-clad metals, can withstand rather severe forming, most parts made from prefinished metals are fairly simple stampings or punchings.

Following are some typical preplated metal parts: chromium-plated steel chime tubes; nickel-plated steel flashlight cases; copper-plated steel picture frames; brass-plated steel lamp tubing; chromium-plated copper reflectors; chromium-plated brass mirror backs; chromium-plated zinc display signs; nickel-plated zinc eraser disks; chromium-plated aluminum lighting fixtures.

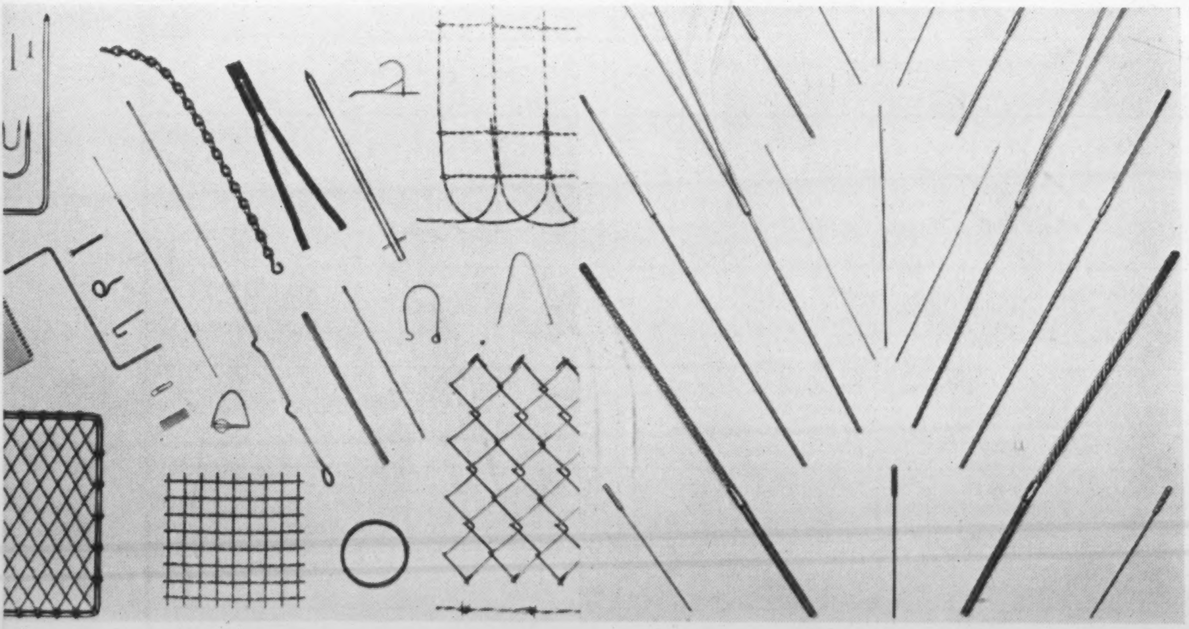
Typical prepainted metal parts include: cellulose-lacquered steel toys; alkyd-enameled aluminum venetian blind slats; and vinyl-lacquered brass lipstick cases. Vinyl-clad steel is being used for business machine housings and TV cabinets.

Surface Properties

When it is necessary that part of a product have certain special surface properties, it is logical to consider first the materials that best supply those critical properties. For many applications, unfortunately, the materials with the most desirable surface properties are too expensive, too low in strength or stiffness, or sometimes both. Sometimes, also, they are scarce. Clad and precoated metals often make it possible to obtain the desired surface properties at much lower cost and without sacrificing structural properties.

All other factors equal, the amount of money that can be saved with clad or precoated metals in such applications depends upon the difference in cost between the face material and the base metal. Laminates with a face of gold, silver, or platinum, for example, offer a greater cost advantage than laminates with a face of nickel, copper, or aluminum. In fact, a laminate with a face of only moderate cost may offer no cost advantage at all, especially in thin sections or small quantities, because the saving in initial materials cost is outweighed by the cost of cladding or coating the base metal. In other words, a clad or precoated metal *can* cost as much or more than an equivalent section of the face material.

Such cost comparisons are irrele-

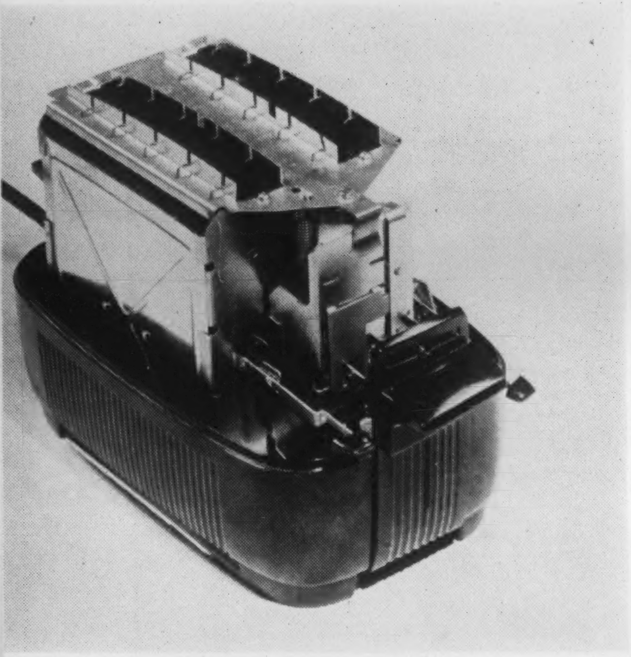


COPPER-CLAD WIRE is used for fencing, costume jewelry, slide fasteners and many other products. Nickel-clad steel wire makes good leads for electrical devices requiring high power input, such as transmitting tubes, outdoor flood lamps and heat lamps. (Copperweld Steel Corp.; Sylvania Electric Products, Inc.)

Common Clad and Precoated Metals—Continued

Face Metal	Base Metal	Form (incl. common thickness range)	How Made	Face (usual thickness, forms)	Critical Functions, Properties	Typical Applications	Some Important Sources
COPPER AND ITS ALLOYS (cont.)							
Copper	Steel, carbon	Wire, 0.006–0.500 in. Also ribbon	Clad by plating, drawing	0.25–35% by wt.	Electrical conductivity. Atmosphere resistance. Strong base metal. Conserves copper	Lead-in wires for electronic tubes, communication and power lines, lightning rods, fencing, springs, plumbing float racks	Kenmore Metals Corp. (Copperon), Sylvania Electric Products, Inc.
Copper	Aluminum (1100 or 5052)	Sheet, strip, 0.004–0.125 in. Also seamless tubing, wire, bus bars	Clad by pressing, rolling	10% of thickness on each side, or 20% on one side. Also 90/10, 70/30, 5/90/5	Thermal, electrical conductivity. Good solderability. Plating base. Lightweight base metal. Conserves copper	Waveguides, variable condenser blades, pots and pans, down spouts, heat transfer fins, jewelry, shims, bushings, terminals	Eastern Brass & Copper Co., Metals & Controls Corp. (Alcuplate)
Copper	Beryllium copper (25)	Strip, 0.010–0.030 in., temper rolled	Clad by direct rolling	10–15% of thickness on one side	Electrical conductivity. Base has good spring properties	Current-carrying springs	Amer. Silver Co., D. E. Makepeace Co.
Copper	Steel, low-carbon	Strip, 0.004–0.125 in., temper rolled	Clad by direct rolling	10 or 15% of thickness on one or both sides	Atmosphere resistance. Compressible surface. Thermal conductivity. Good solderability. Cheap, strong base. Conserves copper	Gaskets, automotive radiator tanks, electrical contact "points" and switches, immersion heater base plates	Amer. Silver Co., Superior Steel Corp. (SuVeneer)
Copper	Steel, high-carbon	Strip, 0.012–0.025 in., annealed	Clad by pressing, rolling	5–20% of thickness on one side, or 10–35% on each side	Electrical conductivity. Plating base. Base has good spring properties	Fuse clips, thin-blade or spiral type springs, plated pen and pencil clips	Metals & Controls Corp. (Conflex)
Copper	Steel, low alloy (with boron)	Wire, 0.003–0.072 in.	Clad by casting, rolling, drawing	10% of radius for "30% conductivity", 12½% for "40% conductivity"	Electrical conductivity. Atmosphere resistance. Plating base. Strong base metal. Conserves copper	Grid support rods for electronic tubes, communication lines, slide fasteners, plated costume jewelry, lawn mower baskets, fencing, ground rods	Copperweld Steel Co.
Copper	Steel, carbon or low-alloy	Plate, 3/16–1¼ in. Also heads	Clad by direct rolling	10–20% of thickness on one side	Resistance to corrosion, erosion. Uniform heat transfer. Conserves copper	Chemical process equipment	Lukens Steel Co.
Cupro-nickel	Steel, low-carbon	Strip, 0.004–0.125 in., temper rolled	Clad by direct rolling	10 or 15% of thickness on one or both sides	Same as above	Chemical process equipment	Amer. Silver Co., Superior Steel Corp. (SuVeneer)
Phosphor Bronze (C)	Copper	Strip, 0.012–0.025 in., spring temper	Clad by direct rolling or pressing, rolling	25% of thickness on each side. Also 35/30/35	Good spring properties. Base has high electrical conductivity	Flat spring blades for switches and electrical meters, other current-carrying springs	Amer. Silver Co., D. E. Makepeace Co., Metals & Controls Corp. (Bronco)
CHROMIUM							
Chromium (over Ni)	Aluminum, brass, copper, zinc	Sheet, strip, 0.005–0.230 in., temper rolled	Electroplated	0.15–0.25 mils on one or both sides. Natural, satin or bright. May be striped, crimped, corrugated	Decoration	Toys, reflectors, trim, squeegee plates, etched nameplates, display signs, grilles and louvers, miniature letters, auto accessories	Amer. Nickeloid Co., Apollo Metal Wks.
Chromium (over Ni)	Steel, low-carbon	Sheet, strip, 0.004–0.250 in., temper rolled	Electroplated	Same as above	Decoration, atmosphere resistance	Switchplates, heater parts, mirror backs, display stands, ferrotype plates, toaster shells, chime tubes	Amer. Nickeloid Co., Apollo Metal Wks., Pittsburgh Steel Co.
GOLD AND ITS ALLOYS							
Gold (10K or more)	Bronze, nickel silver, nickel, sterling silver	Strip, 0.007–0.120 in. Also tubing, wire	Clad by brazing, rolling	More ("gold-filled") or less ("rolled gold plate") than 1/20 by wt. on one or both sides	Decoration. Atmosphere resistance. Relatively low-cost base	Jewelry, including watchcases, bracelets, rings, lockets, eyeglass frames	D. E. Makepeace Co., Metals & Controls Corp.
Gold (14K or more)	Copper, brass, nickel, monel	Strip, 0.010–0.030 in., temper rolled	Clad by brazing, rolling	0.5 or more mils	Chemical resistance. Relatively low-cost base	Bursting disks, other chemical process equipment	Amer. Silver Co.
LEAD AND ITS ALLOYS							
Lead (sometimes over Cd)	Steel, low-carbon	Sheet, strip, 0.005–0.125 in.	Electroplated	¼, ½ or 1 mil min on each side (ASTM B 200). Natural or polished	Atmosphere resistance. Good solderability, drawability. Paint base	Telephone cable sheathing, containers	Pittsburgh Steel Co.

(table continued on page 121)



***ALUMINIZED STEEL SHEET** is used for its heat reflectivity in toaster parts. (Armco Steel Corp.)*

vant when the use of the monolithic face material would not be technically feasible anyway. If the face material alone does not have enough strength or stiffness for the job, a laminate may be *required* to obtain the special properties offered by the face material. Tin and lead, for example, cannot be used alone as structural materials; they must be backed up by a stronger material, usually steel. Even good structural materials such as copper, brass and aluminum must sometimes be backed by steel to avoid an unwieldy design resulting from too large a section, too much weight, or both.

A clad metal or an organic-clad metal must ordinarily be purchased outside, since the characteristic high-quality bond between the two materials cannot be produced with normal plant equipment. Assuming, however, that some other type of laminate is desirable for either technical or economic reasons, why is it often cheaper to buy it than to laminate the fabricated part? As in the case of prefinished metals, the answer lies in the cost advantages inherent in laminating large quantities of flat stock on a continuous line. These advantages have previously been discussed in greater detail for preplated metals, and the case for pre-hot dipped metals is similar. Although the premium paid for a precoated metal is often less than the cost of laminating the fabricated part, the apparent saving may sometimes be offset by an increase in the cost of fabricating the part.

A great variety of surface properties are supplied by clad and precoated metals. The most important are indicated below along with representative laminates and applications.

Corrosion Resistance

Probably the most important surface property that can be provided by any material is corrosion resistance. Clad and precoated metals are often used where resistance to atmospheric corrosion, resistance to chemicals, or resistance to high-temperature oxidation is required.

Atmosphere resistance — Ordinary steel readily discolors and corrodes even in an indoor atmosphere. To give steel a permanently attractive appearance, it is necessary to provide it with an attractive face material that resists the atmosphere and bars its access to the steel base. In this sense, the function of the face material of many prefinished metals, especially steels, can be considered to be atmosphere resistance as well as decoration.

The most common materials in which atmosphere resistance itself is a critical function are hot-dip and electro-galvanized steel sheet and strip, widely used as an outdoor building material, and tinplate, where the thin exterior coating on a steel can is sufficient to protect it from a normal indoor atmosphere. Other steel-base materials include sheet preplated or pre-hot dipped with lead for ammunition boxes and other containers; terne plate for roofing; copper-clad wire for slide fasteners and lawn mower baskets; wire pre-hot dipped with zinc or aluminum for fencing and guy wires; tubing pre-hot dipped with zinc for hot air conduits; and tubing prepainted with black enamel for electrical conduits.

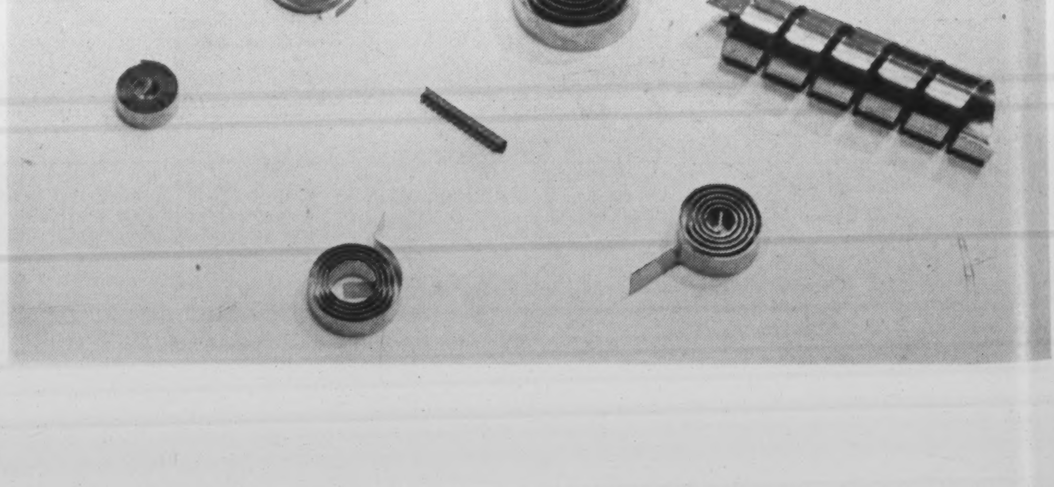
Prepainted steels and steels preplated with decorative coatings are seldom used in outdoor applications, since the coatings are usually too thin to offer adequate protection. However, other prefinished metals are sometimes used in outdoor applications where the face material, though thin, probably contributes to atmosphere resistance as well as an attractive appearance. An example is nickel-plated zinc license plate frames.

Other materials where atmosphere resistance is important are alclad sheet for aircraft, alclad wire for insect screening, and copper sheet preplated with lead for roofing.

Chemical resistance—Some preplated and pre-hot dipped metals are suitable for relatively mild chemical environments. For example, electrolytic or hot dip tinplate is used for cans containing corrosive foods, terne plate is used for gasoline tanks, and copper-plated steel strip is used for oil cans.

The discontinuities and limited thickness of plated and dipped coatings, however, make them unsuitable for severe environments. Vinyl-clad steel sheet is expected to be useful for acid-resistant tanks, ducts and fume hoods. Otherwise, where

***THERMOSTATIC BIMETALS** take many different shapes. (American Silver Co.)*



Common Clad and Precoated Metals—Continued

Face Metal	Base Metal	Form (incl. common thickness range)	How Made	Face (usual thickness, forms)	Critical Functions, Properties	Typical Applications	Some Important Sources
LEAD AND ITS ALLOYS (cont.)							
Lead	Copper (ASTM B 101)	Sheet, strip, 0.019–0.028 in.	Plated (Type II) or hot dipped (Type I)	0.060–0.075 (A), 0.10–0.15 (B) or 0.20–0.25 (C) lb/sq ft on each side	Atmosphere resistance	Roofing, flashing	Amer. Brass Co., Bridgeport Brass Co., Chase Brass & Copper Co., C. G. Hussey & Co., Revere Copper & Brass, Inc.
Lead (ASTM B 29)	Copper, low-carbon steel	Tubing, ¾–2⅛ in. o. d.	Clad by extruding or simultaneous drawing	3/32–½ in. on outside	Chemical resistance. Low cost. Base has good strength, high thermal conductivity	Heat exchanger coils for chemical process equipment	Knapp Mills, Inc. (Cupralum)
Lead (ASTM B 29)	Steel, low-carbon	Plate, sheet, strip, ½–10 in. Also rod, angles, channels	Clad by casting, pressing	⅛–½ in. (chemical) up to 8–10 in. (radiation) on one side	Chemical resistance. High density. Low cost. Strong base metal	Chemical process equipment; equipment for use with x-rays, radium and nuclear processes	Knapp Mills, Inc. (Ferrolum)
Lead (90–95%)	Steel, low-carbon	Sheet, strip, 0.005–0.125 in.	Hot dipped	0.35 oz/sq ft on each side. Natural or polished	Atmosphere resistance. Good solderability, drawability. Paint base. Higher corrosion resistance than terne plate	Ammunition boxes, ducts	Pittsburgh Steel Co.
Terne (75–85% Pb)	Steel, low-carbon	Sheet, 0.019–0.063 in.	Hot dipped	0.16–0.80 mils on each side	Atmosphere resistance. Good solderability, drawability. Excellent paint base. Low cost	Gasoline tanks, caskets, paint and oil containers, door frames	Follansbee Steel Corp., Weirton Steel Co.
NICKEL AND ITS ALLOYS							
Inconel, monel	Steel, carbon or low-alloy	Plate, 3/16 to 1¼ in. (double-clad) or 3½ in. (single-clad). Also heads	Clad by direct rolling	5–25% of thickness on one side, or 5–15% on each side	Resistance to corrosion, erosion. Uniform heat transfer. Low-cost base metal. Conserves nickel	Process industries equipment	Lukens Steel Co.
Monel	Steel, low-carbon	Strip, 0.010–0.030 in. temper rolled	Clad by direct rolling	10–15% of thickness on one or both sides	Same as above	Process industries and marine equipment	Amer. Silver Co.
Nickel	Aluminum, brass, copper, zinc	Sheet, strip, 0.005–0.230 in., temper rolled	Electroplated	0.15–0.20 mils on one or both sides. Natural, satin or bright. May be striped, crimped, corrugated	Decoration	Lighting fixtures, nameplates, fryer lids, broiler pan grids, ice bag caps, eraser disks, license plate frames, buttons	Amer. Nickeloid Co., Apollo Metal Wks.
Nickel	Copper	Wire, 0.001–0.312 in. Also ribbon	Clad by plating, drawing	0.1–25 mils	High-temperature oxidation resistance. Electrical conductivity	Electrical circuits subjected to high temperatures	Kenmore Metals Corp., Sylvania Electric Products, Inc.
Nickel (over Cu)	Steel, low-carbon	Sheet, strip, 0.004–0.250 in., temper rolled	Electroplated	0.15–0.20 mils on one or both sides. Natural, satin or bright. May be striped, crimped, corrugated	Decoration, atmosphere resistance	Toys, brush ferrules, nameplates, tack beading, paint test panels, broiler trays, fan blades, knives, chocolate molds, flashlights	Amer. Nickeloid Co., Apollo Metal Wks., Pittsburgh Steel Co.
Nickel	Iron or carbon steel	Wire, 0.006–0.500 in. Also ribbon	Clad by plating, drawing	0.1–25 mils (½–10% by wt.)	Atmosphere resistance. High-temperature oxidation resistance	Grid support rods, lead-in wires for electronic tubes; typewriter key levers, springs, clothes racks, stapling and stitching wire	Kenmore Metals Corp. (Ferniklon), Sylvania Electric Products, Inc. (Pliron)
Nickel (A)	Copper	Wire, 0.001–0.500 in. Also ribbon	Clad by swaging, drawing	27–30% by weight	Corrosion resistance. Electrical conductivity	Electrical circuits subjected to corrosive atmospheres	Sylvania Electric Products, Inc. (Kulgrid)
Nickel (A or L)	Steel, carbon or low-alloy	Plate, 3/16 to 1¼ in. (double-clad) or to 4 in. (single-clad). Also heads	Clad by direct rolling	5–30% of thickness on one side or 5–15% on each side	Resistance to corrosion, erosion. Uniform heat transfer. Low-cost base metal. Conserves nickel	Process industries equipment	Lukens Steel Co.
Nickel (L)	Brass, low-carbon steel	Strip, 0.010–0.030 in., temper rolled	Clad by rolling	10–15% of thickness on one or both sides	Same as above	Process industries equipment	Amer. Silver Co.
Nickel (330)	Steel, low-carbon	Strip, 0.005 in., annealed	Clad by pressing, rolling	10% of thickness on each side. Often carbonized	High-temperature oxidation resistance. Black body radiation. Low-cost base metal. Conserves nickel	Anode plates for electronic receiving tubes	Metals & Controls Corp. (Nifer), Superior Steel Corp. (SuVeneer)

(table continued on page 123)

chemical resistance or lack of product contamination are important, clad metals are the laminates used.

Among the most important materials used are steel plate and sheet clad with copper, lead, nickel, low-carbon nickel, monel, Inconel, or one of many types of stainless steel. Many of these materials are used where resistance to erosion, as well as corrosion, is needed. Clad steel plates are used in heavy equipment such as vats, tanks, stills, kettles and storage tanks for the chemical, food, pharamceutical, petroleum and other process industries. The face metal is selected to meet the specific environment. For example, lead-clad steel is used particularly in contact with sulfuric acid, sulfurous acid and sulfates. Alclad plate and sheet are also used for chemical storage and shipping tanks.

Clad strip and tubing are also used in chemical process equipment. Common strip combinations include steel clad with cupro-nickel, monel or low-carbon nickel. Sometimes a relatively expensive face material may be backed up by a metal other than steel, such as copper, where steel would not provide enough thermal conductivity or itself would be subject to corrosive conditions. Brass clad with low-carbon nickel, gold or platinum, or monel clad with gold or platinum, may be used where contact with water or brine on the reverse side makes necessary a material more corrosion resistant than steel. For heat exchange applications where both chemical resistance and thermal conductivity are important, materials such as stainless-clad copper strip, platinum-clad copper strip and tubing, lead-clad copper and steel tubing, and alclad tubing are used.

Other materials include platinum-clad brass, bronze and nickel tubing; and nickel-clad copper wire which is used in electrical circuits exposed to highly corrosive atmospheres.

High-temperature oxidation resistance—Nickel, chromium, aluminum and silver resist destructive oxidation at high temperatures and are used to protect steel and sometimes copper. In many applications, the face metal provides not only good high-temperature oxidation resistance but also good heat reflectivity. Nickel-clad and silver-clad copper wire are used in high-temperature coils. Nickel-clad steel wire is used for grid support rods in electronic tubes. Steel sheet pre-hot dipped with aluminum is used for oven door liners and toaster parts. Nickel-clad and aluminum-clad steel strip are used for electronic tube anode plates. High-temperature oxidation resistance is also one of several properties needed by electrical contact materials.

Other Surface Properties

Electrical contact—Silver, platinum and platinum group metals have excellent electrical contact properties. Specifically, they have good electrical conductivity and good arc resistance, and their high resistance to oxidation and corrosion enables them to maintain clean contact surfaces. Platinum is more expensive than silver and has less compressive strength at ordinary temperatures, but it has better strength at elevated temperatures. Copper, brass, bronze and nickel strip clad with silver or platinum are used in the manufacture of electrical contacts. Further savings can often be realized by using strip only partially clad with the contact material. Where spring properties are also needed, silver-clad phosphor bronze or silver-clad beryllium copper may be used.

Electrical conductivity—High-frequency electric current is carried only at the surface of a conductor. Thus, the superior electrical conductivity of silver can be utilized in high frequency circuits by means of silver-clad copper wire or strip. The excellent wave transmission characteristics of silver are utilized in waveguides made from silver-clad brass or silver-clad aluminum rectangular tubing. Electrical conductivity is also one of several properties needed by electrical contact materials.

Heat reflectivity — Aluminum, nickel, chromium and silver have high heat reflectivity and are used to protect structural metals such as steel or copper where excessive heat might reduce their effective strength to an unsafe level, and sometimes to increase heating efficiency. In addition to heat reflectivity, the face metal also provides protection against high-temperature oxidation. Steel sheet pre-hot dipped with aluminum is used for hot jet engine parts. Nickel-plated and chromium-plated steel strip are used in table broiler and other oven parts. Silver-clad copper wire is used in high temperature coils.

Radiation shield—It takes a heavy mass to absorb high energy radiation and prevent it from harming nearby persons or contaminating the surroundings. Especially where space is limited, as in portable equipment, lead is favored for radiation shielding because of its high specific gravity. Since lead itself is not a suitable structural material, lead-clad steel is often used for radiation shielding.

High work function—Platinum-clad molybdenum wire is used in vacuum tube grids. Molybdenum provides the necessary high-temperature form stability, but platinum is needed because of its low primary electron emission characteristic.

Solderability—Clad and precoated metals are sometimes used where the principal function of the face metal is to facilitate joining operations. A prepared surface often eliminates separate handling of joining materials and reduces wetting problems, thereby cutting joining time and labor costs. Tin and lead provide a good base for soft soldering, silver for silver soldering, and copper is a good base for both soldering and brazing. Suitable materials include silver-clad and copper-clad aluminum sheet and strip, copper-clad steel strip and wire, copper-plated steel strip, copper-clad stainless steel strip, tinplate, terne plate, and steel pre-hot dipped or preplated with lead. Steel sheet and strip clad with brazing alloy are also available.

Lubrication—Terne plate and lead-coated steel are sometimes used primarily because of improved drawability resulting from the surface lubricating effect of the lead.

Paint base—Some precoated metals are useful for steel products and structures not only because of their atmosphere resistance but also because they provide a good base for the adherence of an organic finish. Steel preplated or pre-hot dipped with lead, and especially terne plate, are widely used for outdoor structures to be painted. Electrogalvanized steel that has been phosphate-treated is used for similar applications and also for home appliances where a long-lasting finish is desirable.

Non-surface Properties

Some of the oldest and best established applications of clad metals are unique and must be considered apart from those where surface appearance or special surface properties are of primary importance.

Thermostat bimetals are an outstanding example. These laminates consist of two metals having differ-

Common Clad and Precoated Metals—Continued

Face Metal	Base Metal	Form (incl. common thickness range)	How Made	Face (usual thickness, forms)	Critical Functions, Properties	Typical Applications	Some Important Sources
PLATINUM AND PLATINUM GROUP ALLOYS							
Platinum, palladium, etc.	Copper, brass, bronze, nickel	Strip, 0.010–0.030 in., temper rolled	Clad by brazing, rolling	1 or more mils on all or part of one or both sides. May be edgelaid, inlaid	Electrical contact properties. High chemical resistance. Low-cost base metal	Electrical contacts, slip rings, chemical crucibles	Baker & Co., D. E. Makepeace Co., Metals & Controls Corp.
Platinum	Copper, brass, bronze, nickel	Tubing, seamless, up to 1¼ in. o. d. Also wire	Clad by brazing, rolling	0.005–0.007 in.	High chemical resistance. Low-cost base metal. Thermal conductivity	Heat exchangers for chemical processes	Baker & Co., Metals & Controls Corp.
Platinum	Molybdenum	Wire, 0.003–0.060 in.	Clad by casting, rolling, drawing	Up to 0.001 in. (38% by wt.)	High work function (low primary electron emission). Refractory base metal	Grids for vacuum tubes, particularly for use with thoriated cathodes	Baker & Co.
SILVER							
Silver	Copper, nickel	Wire, 0.005–0.250 in. Also ribbon	Clad by plating, drawing	0.1–25 mils (½–5% by wt.)	Atmosphere resistance. High-temperature oxidation resistance. Electrical conductivity. Low-cost base	High-temperature coils, high frequency conductors, braiding for radar cables, strings for musical instruments	Kenmore Metals Corp., Sylvania Electric Products, Inc.
Silver	Aluminum (1100, 5052)	Strip, 0.010–0.062 in.	Clad by pressing, rolling	10% of thickness on each side, or 20% on one side. Also 90/10, 70/30, 5/90/5	Electrical contact properties. Electrical conductivity. Light-weight, low-cost base. Decoration	Conductors, contacts in aircraft electrical equipment; costume jewelry	Metals & Controls Corp. (Alsiplate)
Silver	Aluminum, brass	Tubing, seamless rectangular	Clad by pressing, rolling	0.005 in. on inside	Electronic transmission characteristics. Low-cost base	Waveguides for electronic transmission lines	Metals & Controls Corp.
Silver	Beryllium, copper (25)	Strip, 0.010–0.015 in.	Clad by pressing, rolling	15% of thickness on all or part of one or both sides	Electrical contact properties. Electrical conductivity. Base has good spring properties, fatigue life	Contact arms for buzzer circuits, other current-carrying springs	Amer. Silver Co., D. E. Makepeace Co., Metals & Controls Corp.
Silver	Copper, brass	Strip, 0.010–0.020 in., temper rolled	Clad by brazing, rolling	1 or more mils on part or all of one or both sides. May be edgelaid, inlaid	Electrical contact properties. Low-cost base metal	Electrical contacts, slip rings, flexible waveguides	Amer. Silver Co., D. E. Makepeace Co., Metals & Controls Corp.
Silver	Invar	Strip, 0.006–0.008 in., temper rolled	Clad by brazing, rolling	0.2–0.3 mils	Good electrical contact properties. Low thermal coefficient of linear expansion	Television antenna connectors	Amer. Silver Co.
Silver	Monel, nickel	Strip, 0.008–0.020 in., temper rolled	Clad by brazing, rolling	1 or more mils on part or all of one or both sides. May be edgelaid, inlaid	Electrical contact properties. Resistance to corrosion, wear. Low-cost base metal	Electrical contacts subject to corrosive conditions or excessive wear	Amer. Silver Co., Metals & Controls Corp.
Silver	Phosphor bronze (A, C, D)	Strip, 0.006–0.040 in., spring temper	Clad by brazing, rolling	Same as above	Electrical contact properties. Electrical conductivity. Base has good spring properties	Electrical contact springs	Amer. Silver Co., Metals & Controls Corp.
STAINLESS STEEL							
Stainless steel, austenitic (304, 310)	Copper	Strip, 0.010–0.020 in., annealed	Clad by pressing, rolling	25% of thickness on one or both sides	Resistance to corrosion, erosion. Thermal conductivity. Uniform heat transfer. Workable base metal	Heat exchangers for chemical processes	Metals & Controls Corp.
Stainless steel, ferritic (430)	Copper	Strip, 0.025–0.050 in.	Clad by pressing or brazing, plus rolling	20% of thickness on one or both sides	Corrosion resistance. Thermal conductivity. Uniform heat transfer, Workable base metal. Decoration	Pots and pans	Amer. Silver Co., Metals & Controls Corp.
Stainless steel, (most std. types)	Steel, carbon or low-alloy	Plate, 5/16 to 1¼ in. (double-clad) or 4 in. (single-clad) Also heads	Clad by direct rolling	Up to 30% of thickness on one side or 15% on each side	Resistance to corrosion, erosion. Workable low-cost base metal	Process industries equipment	Colorado Fuel & Iron Corp., Lukens Steel Co.
Stainless steel, (sev. std. types)	Steel, low-carbon	Sheet, plate, 0.050–0.250 in., annealed. May be polished	Clad by casting, rolling	20% of thickness on one side	Same as above. Decoration	Process industries equipment, architectural paneling, auto bumpers, grilles and trim cooking utensils, food display cases, hospital sterilizers	Borg-Warner Corp. (IngAclad)

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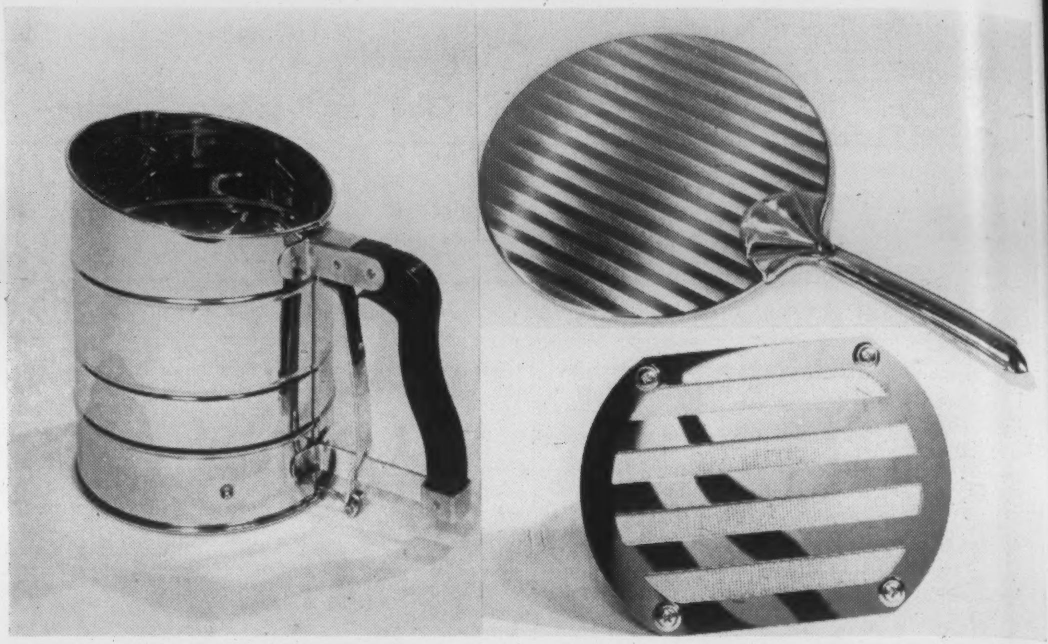


CHROMIUM-PLATED STEEL STRIP *is used to cut the cost of products where appearance is important, such as the flour sifter, mirror back (bright-and-satin striped) and radio speaker grille shown here. (American Nickeloid Co.)*

ent and known thermal coefficients of linear expansion. The function of a thermostat bimetal is to convert heat energy into mechanical work. Exposed to a change in temperature, the laminate undergoes a deflection due to the different rates of expansion or contraction between the two integrally bonded metals. The result is a usable force. These materials, properly calibrated, are used to indicate temperature, as in thermometers, to control temperature, as in furnace controls, and to compensate for temperature changes, as in voltage regulators. Invar is often used for the "low-expansion side" of the bimetal because its thermal coefficient of expansion is virtually zero at ordinary temperatures. Thermostat metals are not standardized industry-wide but a great variety are available to meet different operating temperatures and to provide different degrees of sensitivity. Important producers of these metals, which are not listed in the table, are American Silver Co., W. M. Chace Co., Metals & Controls Corp. and H. A. Wilson Co.

Current-carrying springs are another example. A contact spring used in an electrical switch must have good spring properties, good fatigue life and high electrical conductivity. Some good spring materials such as phosphor bronze and beryllium copper have pretty good electrical conductivity. However, these metals clad with copper or silver offer considerably greater electrical conductivity and often make it possible to reduce the size of the component. A smaller component, in turn, often makes possible a more compact design with resulting economies in materials and fabrication. Copper-clad spring steel is used for similar applications.

Other interesting applications are those in which special combinations of metals are chosen to provide 1) specific corrosion resistance properties on each side, 2) an optimum combination of corrosion resistance and thermal conductivity, or 3) uniform heat transfer. Clad metals of the first two groups have already been discussed under "corrosion resistance" above, although the use of stainless-clad copper or aluminum strip for pots and pans deserves special mention as a non-industrial application of both the second and third principles. In heat transfer, a metal that has relatively low thermal conductivity tends to develop a "hot spot" adjacent to the source of heat, and a metal with high thermal conductivity tends to dissipate heat rapidly and fluctuate rapidly in temperature. A laminate of metals having different thermal conductivities often compensates for both of these tendencies and makes possible much more uniform heat transfer. Clad metals used where uniform heat transfer as well as corrosion resistance is important include not only

VINYL-CLAD SHEET *is being used for business machine housings. (Hood Rubber Co. of B. F. Goodrich Co.)*

Common Clad and Precoated Metals—Concluded

Face Metal	Base Metal	Form (incl. common thickness range)	How Made	Face (usual thickness, forms)	Critical Functions, Properties	Typical Applications	Some Important Sources
STAINLESS STEEL (cont.)							
Stainless steel (430)	Steel, low-carbon	Strip, 0.015–0.095 in., temper rolled	Clad by direct rolling	15% on one or both sides	Corrosion resistance. Decoration. Workable, low-cost base metal	Cooking utensils, auto bumpers, grilles and trim	Superior Steel Corp. (SuVeneer)
TIN							
Tin	Steel, low-carbon	Sheet, strip, 0.008–0.015 in., temper rolled	Electroplated	0.013–0.053 mils on each side. Also 0.013 mils on one side. 0.053 on other. May be chromate-treated	Resistance to atmosphere, chemicals. Good solderability. Strong, low-cost base metal	Tin cans for food products, kitchenware, bearings (as base for babbitting), parts to be soldered	Inland Steel Co., U. S. Steel Corp., Weirton Steel Co., Youngstown Sheet & Tube Co.
Tin	Steel, low-carbon	Sheet, strip, 0.005–0.125 in., temper rolled	Hot dipped	0.066 ("common") or 0.080 ("std") mils on each side. Natural or polished	Same as above	Tin cans for food products	Same as above, Pittsburgh Steel Co.
ZINC							
Zinc	Steel, low-carbon	Sheet, strip, 0.005–0.125 in., temper rolled. Also flat wire	Electroplated	0.01, 0.084 or 0.17 mils on each side. May be phosphate-treated	Atmosphere resistance. Galvanic protection. Strong, low-cost base metal	Lighting fixtures, venetian blind heads, screen frames, refrigerator parts, sliding door tracks, spools and reels, oil cans, signs, auto window channels	Pittsburgh Steel Co., Weirton Steel Co. (Weirzin)
Zinc	Steel, low-carbon	Sheet, strip, 0.012–0.172 in., annealed	Hot dipped	0.8–2.0 mils on each side. May be chromate-treated	Same as above	Roofing and siding, agricultural equipment, refrigerator and air conditioner parts, auto mufflers	Continental Steel Corp., Inland Steel Co. (Ti-Co), Newport Steel Corp., U. S. Steel Corp., Weirton Steel Co.
Zinc	Steel, carbon or low-alloy (ASTM A 53)	Tubing, ½–1 in. Pipe, ½–12 in. Also conduit	Hot dipped	0.002 in. or more on each side	Same as above	Water pipe. Electrical and hot air conduits	Youngstown Sheet & Tube Co. (Yoloy)
Zinc	Steel, low-carbon	Wire, 0.016–0.500 in.	Hot dipped	0.1–1.0 mil	Same as above	Fencing	Continental Steel Corp., U. S. Steel Corp.
ORGANIC COATINGS							
Alkyd baked enamel	Low-carbon steel, aluminum	Strip, 0.005–0.050 in., phosphate-coated	Painted	½–1 mil on each side. All colors. Low- or high-formability types	Decoration, atmosphere resistance	Venetian blind slats, curtain rod brackets, calendar frames, auto dashboards, lighting fixture moldings, awnings	Enamelstrip Corp., Rodney Metals, Inc.
Cellulose lacquer	Steel, low-carbon	Strip, 0.005–0.050 in., May be precoated with copper, brass, nickel or zinc; also phosphate-coated	Painted	½–1 mil on one or both sides. Clear, all colors	Same as above	Toys, novelties, display frames, premium items. brackets, auto moldings and trim	Enamelstrip Corp., Pittsburgh Steel Co.
Organic finish (all types)	Steel (incl. electrogalvanized, tinplate), aluminum, brass, zinc	Strip, 0.006–0.040 in.	Painted	0.1–2.0 mils on one or both sides. Clear, all colors	Same as above	Toys, buttons, buckles, clips, reflectors, picture frames, eraser shields, bottle caps, movie reels, addressograph plates, ashtrays	Enamelstrip Corp.
Polyvinyl chloride	Steel, aluminum, magnesium	Sheet, strip, plate 0.010–0.250 in.	Clad by adhesive bonding with heat and/or pressure	0.008–0.030 in. on one or both sides. All colors, special textures	Decoration. Resistance to atmosphere, chemicals. Abrasion resistance. Formability. Low-cost base metal	Business machine housings, auto instrument panels, television cabinets, airconditioner housings and drip pans; acid-resistant tanks, ducts and fume hoods	Clad-Rex Steel Co. (Marvinol-Metal Laminate), Hood Rubber Co. (Geon Clad Metal), O'Sullivan Rubber Corp. (Sullvyne Clad)
Vinyl lacquer or enamel	Low-carbon steel, aluminum, brass, zinc	Strip, 0.005–0.050 in. Phosphate-coated	Painted	0.4–1.0 mils on one or both sides. All colors	Decoration. Atmosphere resistance. Formability	Bottle caps, lipstick cases, garden tools, toys, battery caps, wall tile, eyelets, flashlight parts	Apollo Metal Wks., Enamelstrip Corp., Rodney Metals, Inc.

stainless-clad copper strip, but also steel plate or strip clad with copper, nickel, cupro-nickel, monel, Inconel and stainless steel.

Each of these applications depends upon combinations of properties that are unique with clad metals. For such applications, clad metals cannot be either technically or economically compared with other materials.

The usefulness of several other laminates depends at least partly upon a chemical or electrochemical relationship between the two materials. Best known examples are galvanized steel and the alclads; in each case the face metal is anodic to the base and therefore protects it by corroding preferentially. Not so well known is the chemical reaction that occurs between iron and aluminum at about 1000F. The resulting alloy is dark in color and refractory in nature. Aluminum-clad steel strip may be used instead of carbonized nickel for electron tube anodes because the necessary black surface is produced during operation of the tube. Steel sheet pre-hot dipped with aluminum is useful in high-temperature operations not only because of the atmosphere barrier and high heat reflectivity provided by aluminum, but also because of the refractory alloy formed at the interface.

Another application is use of copper-clad aluminum strip for washers and shims to prevent galvanic corrosion in aluminum cabling connectors. The aluminum side contacts the cabling and copper side contacts copper terminal of the switchgear.

Although the precious-clad metals used for jewelry might be considered prefinished metals in view of the importance of appearance, they actually represent a special field in themselves. Not only appearance, but also long life and intangible values are involved. Common materials are bronze, nickel silver, nickel or sterling silver clad with gold or alloys of gold with silver, copper, zinc and nickel. The quality of jewelry is determined by the purity of the gold, its thickness and the durability or value of the base metal.

Properties, Fabrication and Cost

Although the scope of this article does not permit detailed information on specific materials, certain factors concerning properties, fabrication and cost of clad and precoated metals should be recognized. These factors are discussed briefly below.

Properties

Provided that the face material has not been damaged during fabrication, the end properties of preplated, prehot dipped and prepainted metal parts are about the same as those of parts which have been carefully plated, hot dipped or painted after fabrication. In either case, such parts should not ordinarily be subjected to abrasive wear, sudden impact, bending deflections or, if the base and face materials differ in thermal coefficient of expansion, large temperature changes that might destroy the coating or the bond.

Many useful clad metals consist of two metals having quite different thermal coefficients of linear expansion. Unless the characteristic "thermostat metal" reaction to heat is desired, the material must be thick enough to remain rigid at operating temperatures. If the material is rigid, of course, the restraint adds a biaxial tensile load to the low-expansion metal and a compressive load to the high-expansion metal. This is not a serious problem because in most clads the base is the low-expansion metal and the undesirable tensile load is distributed across a proportionately large cross section. Rigidity can also be obtained by using a double-clad metal.

For the purpose of determining conductivities of clad metals, it is possible to consider them as analogous to different types of electrical circuits. Thermal conductivity through the cross section may be calculated by assuming a series circuit, i.e., adding the weighted resistances where resistance is the reciprocal of conductivity. In steel clad with 20% copper, for example, the weighted resistance of steel ($0.8/312 = 0.00256$) is added to the weighted resistance of copper ($0.2/2616 = 0.00008$) to find the total resistance (0.00264). Thus, thermal conductivity of the clad metal is equal to the reciprocal of 0.00264 or 380 Btu/hr/sq ft/°F/in. This value is 23% of that of solid copper and 22% higher than that of solid steel.

Similarly, electrical conductivity in the linear direction may be calculated by assuming a parallel circuit, i.e., adding the reciprocals of the weighted resistances. In high-carbon steel clad with 20% copper, for example, the reciprocal of the weighted resistance of steel ($0.8/18 = 0.0444$) is added to the reciprocal of the weighted resistance of copper ($0.2/1.7 = 0.117$) to find the reciprocal of the total resistance (0.161). Thus, resistivity of the clad metal is the reciprocal of 0.161 or 6.2 microhm-cm. Electrical conductivity is about 27% of that of solid copper and 65% higher than that of solid steel.

These figures also show that the addition of a thin layer of a highly conductive metal to a less conductive one is much more effective in raising over-all electrical conductivity (linear) than in raising over-all thermal conductivity (transverse).

It is often said that the over-all mechanical properties of a clad metal lie somewhere between those of the monolithic metals. This is only partly true. Certainly it would be risky always to assume, as is sometimes suggested, that the strength of a clad metal is equal to the weighted average of the strengths of the monolithic metals. It is a good approximation if the two metals have about the same strength and the same elastic moduli, e.g., nickel-clad steel. But it pays to remember that the two metals, though intimately bonded, never lose their separate identities.

For example, assume a steel (25,000 psi yield strength) clad with 20% stainless (50,000 psi yield strength). The weighted average yield strength of the clad is 30,000 psi. Assume a tensile load of 28,000 psi. Since the moduli of the two metals are about equal, each is stressed at about 28,000 psi—a stress below the predicted yield strength of the clad. Yet, the yield strength of the steel has already been exceeded and the steel base has been permanently deformed.

Or, assume the same clad with 20% aluminum (10,000 psi yield strength). The weighted average yield strength of the clad is 22,000 psi. However, the elastic modulus of steel is three times that of aluminum; hence, at any extension, the stress in steel is three times that in aluminum. Taking into account both the 4:1 volume factor and the 3:1 modulus factor, it can be shown that the steel carries about 92% of any applied tensile load. Assume a tensile load of 20,000 psi—a load below the predicted yield strength of the clad. The stress in the steel (20,000 x 0.92/0.8) is 23,000 psi and the yield strength of the steel has been exceeded. In contrast, the stress in the aluminum is only 7700 psi. Thus, in this case, the stronger metal is the limiting metal in design.

In conservative design, such as that promulgated by the ASME Boiler Code Committee, these problems are avoided. Where the face metal equals or exceeds the base metal in strength, as in stainless- or nickel alloy-clad steel, it is permissible to use the full thickness of the clad, but only the properties of the base metal, as the basis for design. Where the face metal is not as strong as the base metal, as in copper- or aluminum-clad steel, it is permissible to use the properties of the base metal, but only the thickness of the base metal, as the basis for design.

Like other laminates, clad metals are subject to the formation of unfavorable galvanic couples. Attack at exposed edges may be significant in thick clads, especially if the face metal is anodic to the base. Otherwise, the corrosion resistance of a clad metal is usually determined by the corrosion resistance of the face metal. However, exceptionally thin strip should not be specified where good corrosion resistance is important or a high electrochemical potential exists between the two metals, since the face metal may be rolled down to the extent that it is no longer continuous. Under such conditions the normal distinction between clad and plated metals becomes academic.

Fabrication

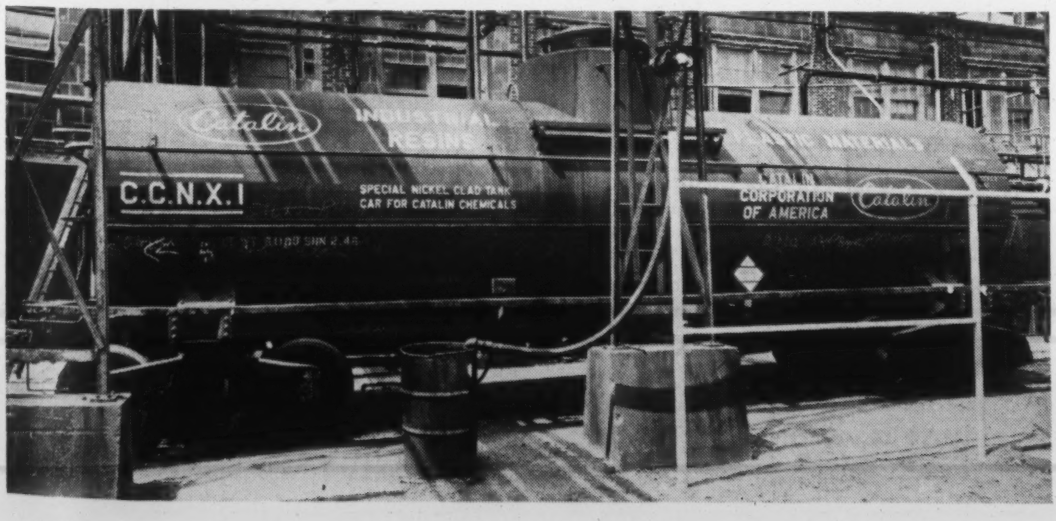
A laminate always implies certain limitations in fabrication. In the forming, joining, heating, cleaning and finishing of clad and precoated metals, not only the difference in properties of the two materials, but also the nature of the bond and the thickness of the face material must be considered.

Forming—In forming clad and precoated metals, a certain amount of care is necessary to avoid three characteristic types of failure: destruction of one of the materials, destruction of the bond and damage to the surface.

Although the machining, punching, blanking and similar working characteristics of clad metals lie somewhere between those of the two metals, the limits in bending and drawing operations are set by the less formable of the two metals. The common precoated metals, such as terne plate and modern galvanized steel, can be worked about as readily as uncoated low-carbon steel. Lead and terne coatings actually improve the drawability of steel. Some preplated and prepainted metals also have a lubricating effect on dies. The decorative preplated metals, like other precoated metals, can be successfully stamped, blanked, bent and roll formed, although larger-than-normal radii are desirable. They can be drawn to a limited extent, but are not suitable for deep drawing or spinning. Prepainted metals vary widely in formability depending on the flexibility of the coating. A normal hard alkyd-coated steel has little formability, but a flexible vinyl-coated steel can be deep drawn provided annealing is not required. Prepainted metals are not suitable for spinning. Vinyl-clad steel is readily formable at temperatures not lower than 72 F.

PREPAINTED METAL STRIP is being used for a wide variety of products. Most common finishes are cellulose, alkyd and vinyl lacquers and enamels. (Enamelstrip Corp.)

GALVANIZED STEEL SHEET makes this air-conditioning boot atmosphere-resistant and attractive in appearance. (Armco Steel Corp.)



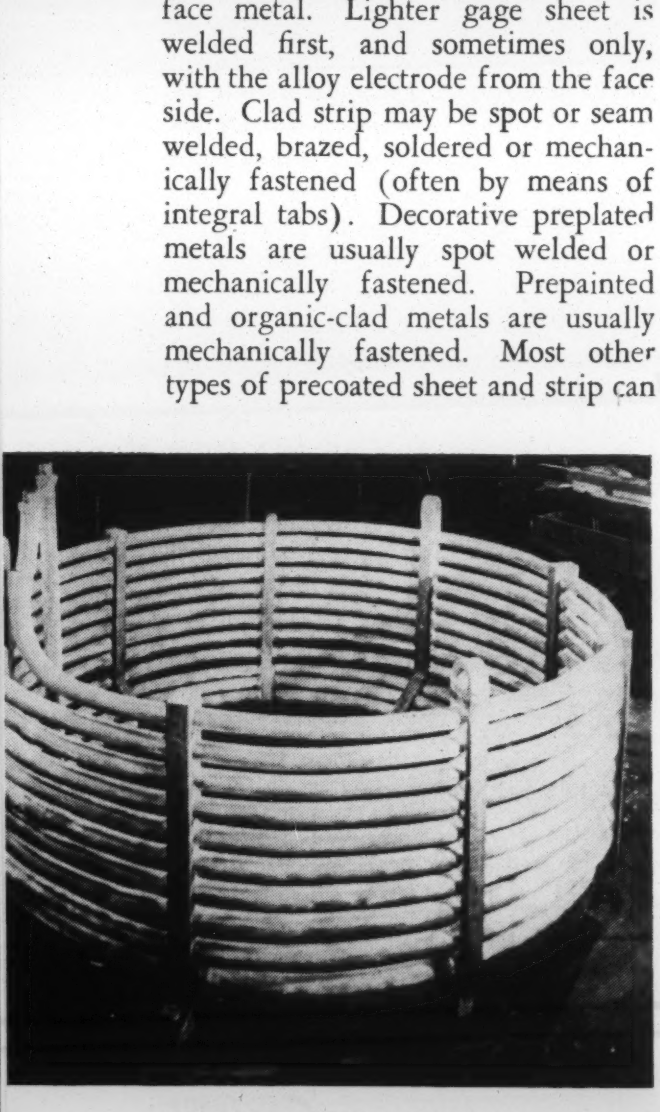
NICKEL-CLAD STEEL PLATE was used for this tank car which has been transporting chemicals such as caustic soda and phenol since 1930. (Lukens Steel Corp.)

Protection of the surface from gouging, scratching or imbedment of foreign particles is particularly important where either attractive appearance or corrosion resistance is desired. Clad and precoated metals are fabricated with face material up in order to throw the burr on the other side and otherwise minimize surface damage. Rolls, dies and tools are kept free of loose particles. The face material of metal-metal laminates is often protected by a pasted paper cover or a strippable plastic coating. Prefinished metals must always be handled as carefully as finished parts, not as raw stock.

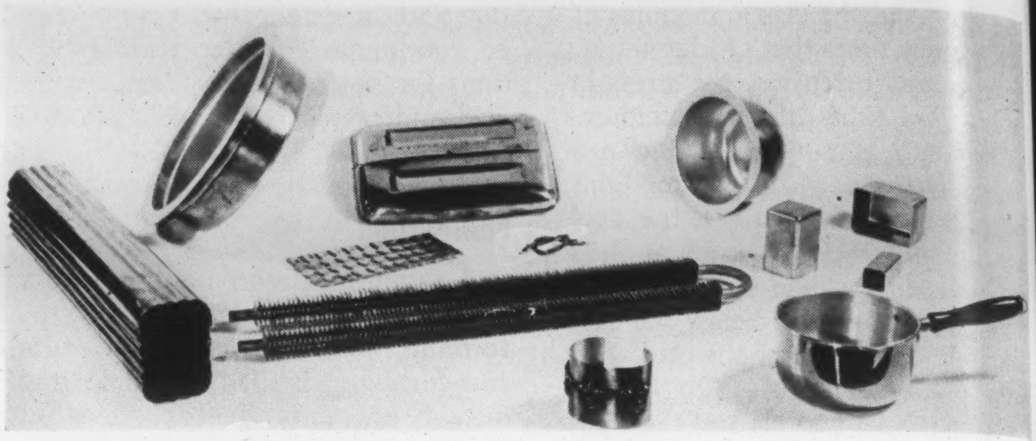
Heating and Joining—Since many common joining methods require considerable heat, the problems involved in heating and joining clad and precoated metals are often closely related. For all practical purposes, prepainted and organic-clad metals cannot be heated. Excessive heating of decorative preplated metals may damage the surface finish by oxidation. Clad metals may be distorted by the characteristic "thermostat metal" reaction.

In many clad and precoated metals heat treating or joining temperatures that are optimum for one of the metals would melt, soften or destroy desirable properties in the other metal. For example, copper-clad steel must be annealed at a temperature considerably below the usual annealing temperature for steel. Lead clad steel cannot be properly welded unless a strip of unclad steel surface is provided. And stress relief of steel plate clad with certain types of stainless must take into account the possibility of carbide precipitation in the stainless.

Clad plates are ordinarily joined by welding. The steel base is welded first with a mild steel electrode, and the face is subsequently welded with an electrode that produces weld metal of the same composition as the face metal. Lighter gage sheet is welded first, and sometimes only, with the alloy electrode from the face side. Clad strip may be spot or seam welded, brazed, soldered or mechanically fastened (often by means of integral tabs). Decorative preplated metals are usually spot welded or mechanically fastened. Prepainted and organic-clad metals are usually mechanically fastened. Most other types of precoated sheet and strip can be joined by all common methods.



LEAD-CLAD COPPER TUBING *is particularly useful in heat exchange applications involving sulfuric acid or related chemicals. (Knapp Mills, Inc.)*



COPPER-CLAD ALUMINUM STRIP *is used for a variety of consumer and industrial applications where appearance, light weight or heat transfer are important. (General Plate Div., Metals & Controls Corp.)*

Cleaning and finishing—Both mechanical and chemical methods of cleaning and finishing must be used with some caution. Mechanical finishing that is too robust may destroy a thin face material by wear, impact or excessive heat. Similarly, a chemical cleaning solution and cycle that are optimum for one of the two materials may result in excessive attack on the other.

Equipment made from clad plate is ordinarily wiped or hosed clean, although local pickling (by means of pastes) and salt bath descaling are sometimes used. Parts made from clad strip or precoated metals are often cleaned by solvent wiping or degreasing, and wheel pressures in polishing or buffing are controlled more or less closely depending on the thickness of the face metal. Light contact pressures are particularly important for the decorative preplated metals. These materials are sometimes patterned by etching. Prepainted and organic-clad metals are cleaned by wiping and are not mechanically finished.

Cost

The utility of a clad or precoated metal, like that of any other engineering material, depends on whether it can do a desired job more cheaply than any other material or method available. The question is: would it be cheaper and equally satisfactory to use a metal laminate rather than—

1. a monolithic material?
2. a mechanical combination of parts made of different materials?
3. plating, dipping, lining or painting the metal after fabrication?

Sometimes the choice is fairly obvious, but often it requires careful consideration of a multitude of factors.

Cost allocation is a big factor. Many finishing departments, for example, are run with inadequate, sometimes antiquated, cost accounting systems. The result may be either an overestimate or an underestimate of the actual cost of finishing fabricated parts in comparison with the extra costs incurred in the purchase and fabrication of prefinished metals.

Another factor is availability. The supply of some materials, especially nickel and tin, is often short or at least undependable. Even if it costs more, a clad that uses less of a scarce metal than an alternative material may be a desirable choice simply because it is easier to get. Even if a frequently-scarce metal is momentarily available, a clad metal may be desirable because of various savings accruing from stability of design and production.

Still another factor is quantity. Many clad strip materials, especially, are produced only to order. Amortization of set-up costs over a short run may result in a price high enough to rule out a potentially attractive application.

Actually, the choices outlined above do not exhaust the possibilities for clad and precoated metals. Some high-production users of laminated metals make their own. Pre-lined plate, made by fabricators of process industries equipment, has already been mentioned. Rodney Metals, a supplier of prepainted strip, originally prepainted strip only for its own production of venetian blinds. The R. C. Mahon Co. prepaints steel strip prior to roll forming the slats for its rolling doors and deck plates

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Materials Engineering File Facts

MATERIALS & METHODS
December • 1954
Number 290

Government Specification Chart for Stainless Steel

Specifications		Type No.	Form	C[1]	Mn[1]	P[1]	S[1]	Si[1]	Ni[2]	Cr[2]	Mo[1]	Other
FEDERAL SPECIFICATIONS												
QQ-S-763a Amend 1	Class 1, Type A	304	Bars and Forgings (Except for reforging)	.08	0.2–2.0	.04	.04	1.0	8.0	18.0	—	—
	Class 1, Type B,C,D	302		.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
	Class 2	325		.50	0.4–0.8	.04	.05	0.5–2.0	19.5	6.5	—	—
	Class 3, Type A,C,E,F	410		.15	1.0	.04	.04	1.0	0.6 Max	11.5–13.5	0.6	—
	Class 4	430		.06–.15	1.0	.04	.04	1.0	0.5 Max	16.0	0.6	—
	Class 5, Type A,F	420		.30–.60	1.0	.04	.04	1.0	0.5 Max	12.0–14.0	—	—
	Class 6, Type A,C,E	416		.15	1.2	See Spec	See Spec	1.0	0.5 Max	12.0–15.0	See Spec	See Spec
	Class 7, Type A,B	303		.12	0.2–2.0	See Spec	See Spec	1.0	8.0	17.0	See Spec	See Spec
	Class 8, Type A	321 or 347		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
	Class 9, Type A,C	316		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	1.75–2.50	—
	Class 10, Type A	440C		.95–1.10	1.0	.04	.04	1.0	0.5 Max	16.0	0.4–0.7	—
QQ-S-766a Amend 1	Class 1, Cond. A	304	Plates, Sheets, Strip and Shapes	.08	0.2–2.0	.04	.04	1.0	8.0	18.0	—	—
	Class 2, Cond. A	302		.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
	Class 3, Cond. A	410		.15	1.00	.04	.04	1.0	0.8 Max	10.0–14.0	—	—
	Class 4, Cond. A,B, C,D,E	302		.09–.20	0.2–2.0	.04	.04	1.0	6.0	17.0	—	—
	Class 5, Cond. A	316		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	1.75–2.5	—
	Class 6, Type A	321 or 347		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
	Class 7, Type A	430		.12	1.0	.04	.04	1.0	0.6 Max	14.0–18.0	—	—
	Alt. for Class 7, if for Quartermaster Corps, Army Service Forces	430		.12	0.5	.03	.03	0.75	0.6 Max	16.0–18.0	—	—
U. S. MILITARY SPECIFICATIONS												
MIL-S-853 (Ships) Amend 1 Supersedes 46-S-18e	Class 1, Type A,B,C	304	Bars and Forgings, except for reforging (For reforging bars and billets See MIL-S-862 (Ships) Amend 2)	.08	2.0	.04	.04	1.0	8.0	8.0	—	—
	Class 2, Type A,B,C	302		.09–.20	2.0	.04	.04	1.0	8.0	7.0	—	—
	Class 3, Type A,C,E,F	410		.15	1.0	.04	.04	1.0	0.6 Max	11.5–13.5	0.6	—
	Class 4	430		.12	1.0	.04	.04	1.0	0.5 Max	16.0–18.0	0.6	—
	Class 5, Type A,F	420		.30–.40	1.0	.04	.04	1.0	0.5 Max	12.0–14.0	—	—
	Class 6, Type A,C,E	416		.15	1.2	See Spec	See Spec	1.0	0.5 Max	12.0–14.0	See Spec	See Spec
	Class 7, Type A,B,C	303		.15	2.0	See Spec	See Spec	1.0	8.0	7.0	See Spec	See Spec
	Class 8, Type A	321 or 347		.08	2.0	.04	.04	1.0	8.0	7.0	—	Ti 5xC Min or Cb-Ta 10xC Min
	Class 9, Type A,C	316		.10	2.0	.04	.04	1.0	10.0	16.0–18.0	2.0–3.0	—
	Class 10, Type A,E,F	431		.20	0.8	.04	.04	1.0	1.25–2.0	15.0–17.0	—	—
	Class 11, Type A	310		.25	2.0	.04	.04	2.0	19.0	24.0–26.0	—	—
	Class 12	325		.50	0.4–0.8	.04	.05	0.5–2.0	19.5	6.5	—	—
MIL-S-854 (Ships) Amend 1 Supersedes 47S20 (Int)	Class 1, Cond. A	304	Plates, Sheets, Strip and Shapes	.08	2.0	.04	.04	1.0	8.0	8.0	—	—
	Class 2, Cond. A,B, C,D,E	302		.09–.20	2.0	.04	.04	1.0	8.0	7.0	—	—
	Class 3, Cond. A	410		.15	1.0	.04	.04	1.0	0.8 Max	11.5–13.5	—	—
	Class 4, Cond. A	430		.12	1.0	.04	.04	1.0	0.6 Max	16.0–18.0	—	—
	Class 8, Cond. A	321 or 347		.08	2.0	.04	.04	1.0	8.0	7.0	—	Ti 5xC Min or Cb-Ta 10xC Min
	Class 9, Cond. A	316		.10	2.0	.04	.04	1.0	10.0	16.0–18.0	—	—
	Class 11, Cond. A	310		.25	2.0	.04	.04	2.0	19.0	24.0–26.0	—	—
MIL-S-861 (Ships) Supersedes 46S12e	Class A	414	Bars	.06–.13	0.25–0.8	.03	.03	.50	0.5 Max	11.5–13.0	—	—
	Class B	414	Bars and Strip	.06–.13	0.25–0.8	.03	.03	.50	1.0 Max	11.5–14.5	—	—
	Class C	416F	Bars and Billets	.07–.12	0.3–0.6	.03	.03	.35	0.6 Max	11.5–12.5	0.4–0.6	—
MIL-S-862 (Ships) Amend 2 Supersedes 46S26a	Classes equivalent to MIL-S-853 (Ships) Amend 1		Bars and Billets (For reforging only)	Analyses are identical to those shown for MIL-S-853 (Ships) Amend 1								
JAN-P-1144 Supersedes 44P16 (Int)	Classes A,B,C	304	Seamless & Welded Pipe and Tubing	.08	0.20–2.00	.03	.04	0.7	8.0	18.0	—	—
MIL-S-4043 (USAF)		04ELC	Plate, Sheet, and Strip	.03	2.0	.04	.03	1.0	8.0–11.0	18.0–20.0	0.5	—
MIL-S-5059 Supersedes AN-QQ-S-772a	Type D	302	Plate, Sheet, and Strip	.12	2.0	.04	.03	1.0	6.5	16.0	0.5	—
	Type G	302		.12	2.0	.04	.03	1.0	8.0–11.0	17.0–20.0	0.5	—
	Type SCR	316		.08	2.0	.04	.03	1.0	10.0–14.0	16.0–18.0	2.0–3.0	—
MIL-T-5695 Supersedes 49T11		304	Streamlined Tubing	.12	0.7	.03	.04	0.7	7.0	17.0	—	—
MIL-W-6713 Supersedes AN-W-24	Grade G	302	Wire	.012	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	—
MIL-S-6721 Supersedes AN-S-757	Composition Tl.	321	Plate, Sheet, and Strip	.08	2.0	.04	.03	1.0	9.0–12.0	17.0–19.0	—	Ti6xC Min-.75 Max
	Composition Cb-Ta	347		.08	2.0	.04	.03	1.0	10.0–13.0	17.0–19.0	—	Cb-Ta 11xC Min 1.35 Max
MIL-T-6737 Supersedes AN-T-82		321 or 347	Welded Tubing	.10	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	Ti 4xC or Cb-Ta 8xC Min-1.0 Max
MIL-T-6845 Supersedes AN-T-86		304	Seamless and Welded Tubing Hydraulic	.08	2.0	.03	.03	.75	8.0	18.0	0.5	—
MIL-T-6846 Supersedes AN-T-43		304	Seamless and Welded Tubing Hydraulic	.08	2.0	.03	.03	.75	8.0	18.0	0.5	—

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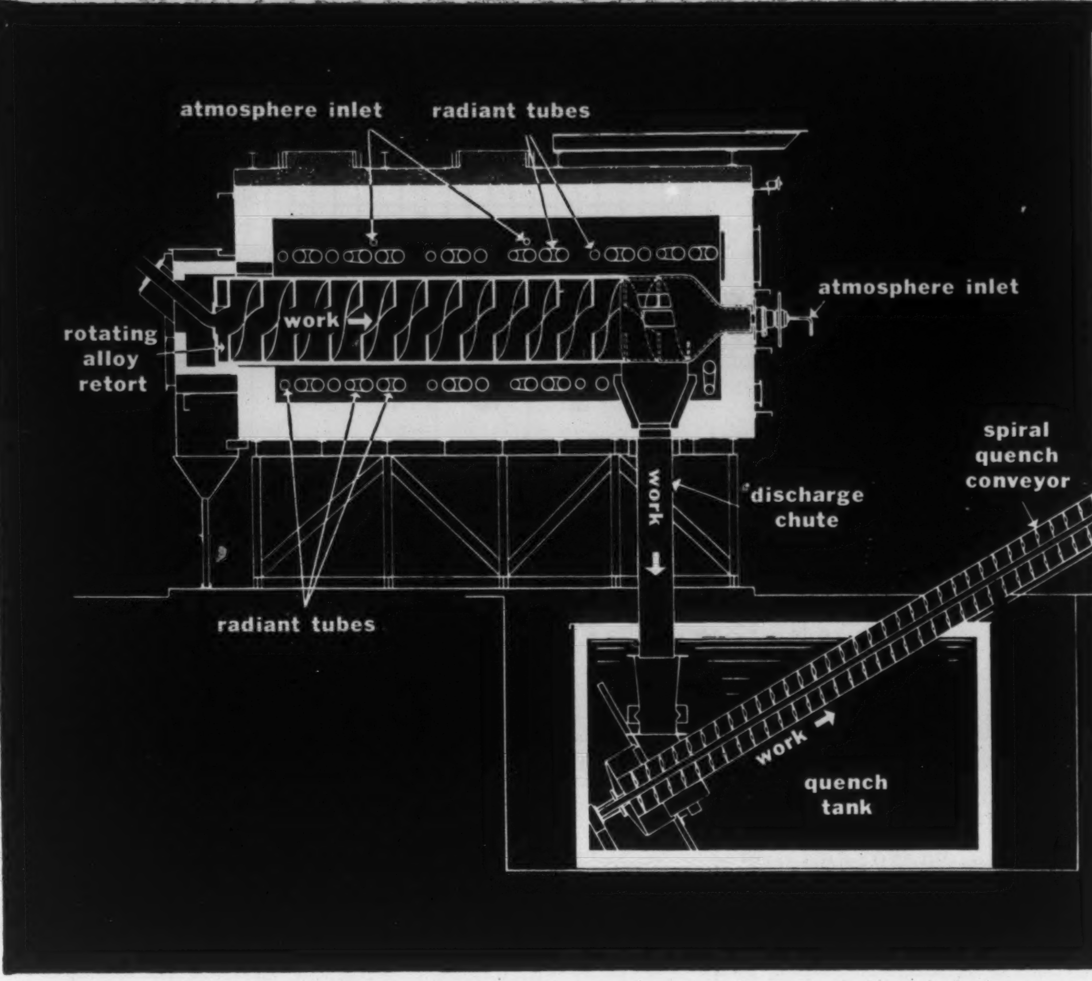
[1] *Maximum, except where otherwise stated or range is shown.*

[2] *Minimum, except where otherwise stated or range is shown.*

◄**For more information, Circle No. 473**

Courtesy of Star Stainless Screw Co.

(Continued on page 133)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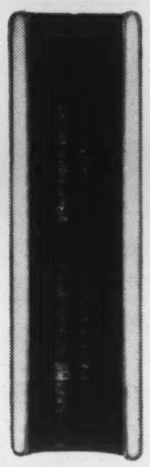
quench tank



Section of AISI-1117 piston pin showing carburized case. Total case depth averages 0.040 inches when carburizing at 1680F with a total time cycle of 7.5 hours.

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MATERIALS & METHODS
December • 1954
Number 290

Government Specification Chart for Stainless Steel—(Continued)

Specifications		Type No.	Form	C[1]	Mn[1]	P[1]	S[1]	Si[1]	Ni[2]	Cr[2]	Mo[1]	Other
U. S. ARMY-NAVY AERONAUTICAL SPEC.												
AN-W-23	Grade MCR	316	Wire	.10	0.2–2.5	.04	.04	0.2–1.5	7.0–14.0	17.0	1.75–2.5	—
AN-W-24	Grade G	302	Wire	.12	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	—
AN-T-43 Amend 2	Composition 1	304	Welded Tubing, Hydraulic	.12	0.2–2.5	.04	.04	0.2–1.5	6.5	17.0	—	—
	Composition 2	321 or 347		.10	0.2–2.0	.04	.04	0.2–1.5	7.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
AN-T-82		321 or 347	Welded Tubing	.10	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
AN-T-86		304	Seamless and Welded Tubing, Hydraulic	.08	2.0	.03	.03	.75	8.0	18.0	—	—
AN-S-757	Composition Ti	321	Plate, Sheet and Strip	.08	2.0	.04	.03	1.0	9.0–12.0	17.0–19.0	—	Ti 6xC Min
	Composition Cb	347		.08	2.0	.04	.03	1.0	10.0–13.0	17.0–19.0	—	Cb-Ta 10xC Min
AN-QQ-S-770a Amend 1		431	Bars	.17	0.3–0.8	.04	.04	0.2–0.6	1.5–2.5	15.5–17.5	—	—
AN-S-771 Amend 1	Composition G	302	Bars	.12	2.0	.04	.03	1.0	8.0–11.0	17.0–20.0	—	—
	Composition MCR	316		.10	2.0	.04	.03	1.0	10.0–14.0	16.0–18.0	2.0–3.0	—
	Composition FMS	303		.12	2.0	.06	.18–.35	1.0	8.0	17.0–20.0	0.6	P+S Min .18
	Composition FMP	303		.12	2.0	.12–.17	.10	1.0	8.0	17.0–20.0	0.6	P+S Min .18
	Composition FMSe	303		.12	2.0	.17	.10	1.0	8.0	17.0–20.0	0.6	Se .15–.35
AN-QQ-S-772a Amend 1	Composition G	302	Plate, Sheet and Strip	.12	0.2–2.5	.04	.04	0.2–1.5	6.5	17.0	—	—
	Composition MCR	316		.10	0.2–2.5	.04	.04	0.2–1.5	7.0–14.0	17.0	1.75–2.5	—
AN-WW-T-855	Amend 2	304	Seamless Tubing	.12	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	—
AN-WW-T-858	Amend 2	321 or 347	Seamless Tubing	.10	0.2–2.5	.04	.04	0.2–1.5	7.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
U. S. NAVY SPECIFICATIONS												
22W13d		316	Wire	.10	0.2–2.5	.03	.03	0.2–1.5	7.0–14.0	17.0	2.0–4.0	—
46S12e	Class A	414	Bars	.06–.13	0.25–0.8	.03	.03	0.5 Max	0.5	11.5–13.0	—	—
	Class B	414	Bars and Strips	.06–.13	0.25–0.8	.03	.03	0.5 Max	1.0	11.5–14.5	—	—
	Class C	416	Bars and Billets	.07–.12	0.3–0.6	.03	.03	0.35 Max	0.6	11.5–12.5	0.4–0.6	—
46S18e	Class 1, Type A	304	Bars and Forgings, except for reforging (For reforging bars and billets 46S26A)	.08	0.2–2.0	.04	.04	1.0	8.0	18.0	—	—
	Class 1, Type B,C,D	302		.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
	Class 2	325		.50	0.4–0.8	.04	.05	0.5–2.0	19.5	6.5	—	—
	Class 3, Type A,C,E,F	410		.15	1.0	.04	.04	1.0	0.6 Max	11.5–13.5	0.6	—
	Class 4	430		.06–.15	1.0	.04	.04	1.0	0.5 Max	16.0	0.6	—
	Class 5, Type A,F	420		.30–.40	1.0	.04	.04	1.0	0.5 Max	12.0–14.0	—	—
	Class 6, Type A,C,E	416		.15	1.2	See Spec	See Spec	1.0	0.5 Max	12.0–15.0	See Spec	See Spec
	Class 7, Type A,B	303		.12	0.2–2.0	See Spec	See Spec	1.0	8.0	17.0	See Spec	See Spec
	Class 8	321 or 347		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
	Class 9, Type A,C	316		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	1.75–2.5	—
	Class 10, Type A,E,F	431		.17	0.3–0.8	.04	.04	0.2–0.6	1.5–2.0	15.5–17.5	—	—
46S26a	Class 1, Type A	304	Bars and Billets (For reforging only)	.08	0.2–2.0	.04	.04	1.0	8.0	18.0	—	—
	Class 1, Type B	302		.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
	Class 2	325		.50	0.4–0.8	.04	.05	0.5–2.0	19.5	6.5	—	—
	Class 3	410		.15	0.6	.04	.04	.75	0.6 Max	11.5–13.5	0.6	—
	Class 4	430		.06–.15	0.2–0.6	.04	.04	.75	0.5 Max	16.0	0.6	—
	Class 5	420		.30–.60	0.2–0.6	.04	.04	.75	0.5 Max	12.0–14.0	—	—
	Class 6	416		.15	1.2	See Spec	See Spec	1.0	0.5 Max	12.0–15.0	See Spec	See Spec
	Class 7	303		.12	0.2–2.0	See Spec	See Spec	1.0	8.0	17.0	See Spec	See Spec
	Class 8	321 or 347		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
	Class 9	316		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	2.0–4.0	—
47S20 (Int)	Class 1, Cond. A	304	Plates, Sheets, Strip and Shapes	.08	0.2–2.0	.04	.04	1.0	8.0	18.0	—	—
	Class 2, Cond. A	302		.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
	Class 3, Cond. A	410		.15	1.0	.04	.04	1.0	0.8 Max	10.0–14.0	—	—
	Class 4, Cond. A,B C,D,E	302		.09–.20	0.2–2.0	.04	.04	1.0	6.0	17.0	—	—
		316		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	1.75–2.5	—
	Class 5, Cond. A Class 6, Cond. A	321 or 347		.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min
47S22a		302	Plate and Sheet	.12	0.2–2.0	.04	.04	1.0	8.0	17.0	—	—
47S30	Class 1	304	Clad: Plate, Sheet and Strip	.08	2.5	.04	.04	.75	8.0	18.0	—	—
	Class 2	302		.12	2.5	.04	.04	.75	6.0	16.0	—	—
	Class 3	430		.06–.15	0.75	.04	.04	.75	0.8 Max	15.0	0.6	—
	Class 4	347		.10	2.5	.04	.04	.75	8.0	17.0	—	Cb-Ta 8xC Min
49T11		304	Streamlined Tubing	.12–.15	0.7	.03	.04	.70	7.0	17.0	—	—
U. S. ARMY SPECIFICATIONS												
48-42	Amend 1	420	Wire	.30–.40	0.6	.03	.03	.50	0.5 Max	12.0–14.0	—	—
48-43	Amend 1	302	Wire	.12	0.2–2.0	.04	.04	1.0	7.0	17.0	—	—
57-180-3e		321 or 347	Seamless and Welded Tubing	.10	0.2–2.0	.04	.04	1.0	8.0	17.0	—	Ti 4xC Min or Cb-Ta 8xC Min

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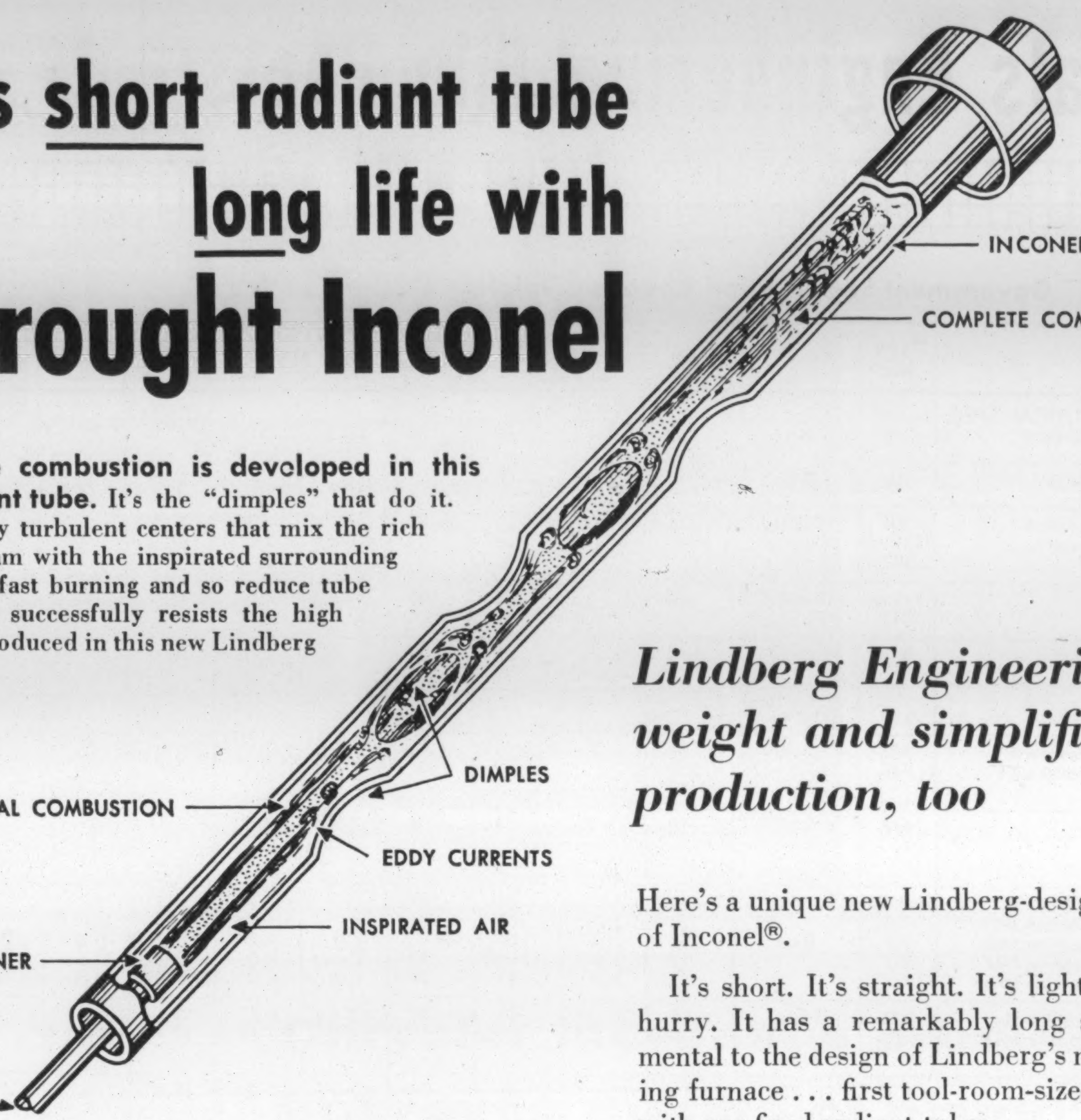
[1] *Maximum, except where otherwise stated or range is shown.*

[2] *Minimum, except where otherwise stated or range is shown.*

Gives short radiant tube long life with wrought Inconel

Short intense combustion is developed in this Inconel radiant tube. It's the "dimples" that do it. They set up tiny turbulent centers that mix the rich central gas stream with the inspirated surrounding air to promote fast burning and so reduce tube length. Inconel successfully resists the high temperatures produced in this new Lindberg development.



Lindberg Engineering saves weight and simplifies production, too

Here's a unique new Lindberg-designed radiant tube made of Inconel®.

It's short. It's straight. It's light. It transfers heat in a hurry. It has a remarkably long service life. It's fundamental to the design of Lindberg's new atmosphere hardening furnace . . . first tool-room-sized unit ever to be heated with gas-fired radiant tubes.

What the new tube does, is to develop as much combustion as in a standard long tube . . . but develop it in shorter time and hence, shorter length.

What Inconel does, is to provide within a light, thin-wall tube the strength and heat resistance needed to contain this short, intense combustion. Inconel also contributes rapid heat transfer properties and lends itself well to production by conventional methods.

For instance, the seamless Inconel tube is easily "dimpled" (to shorten and intensify combustion) about one-inch deep on six-inch off-set centers along the tube.

What wrought Inconel contributes to Lindberg's unique new radiant tube, it contributes to heat treating fixtures made by many other fabricators . . . built-in long life, strength and corrosion resistance at high temperatures and in most furnace atmospheres; excellent fabricating characteristics.

So, if these are qualities you need, look to Inconel. You can get more information on this useful Inco-Nickel Alloy in the Inco booklet, "Keeping Costs Down . . . as temperatures go up." Write for it, today.

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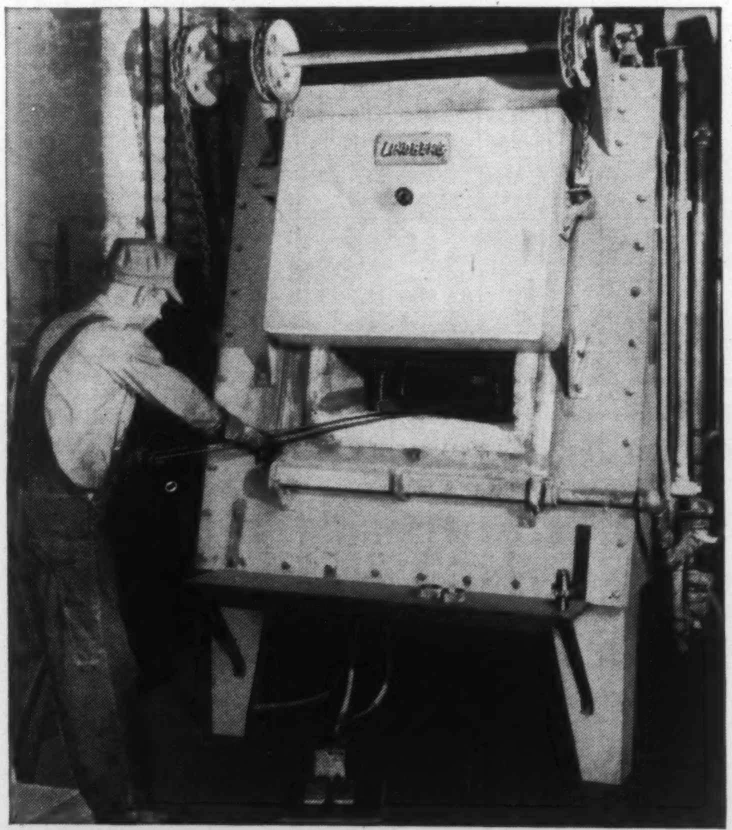

First tool-room sized radiant-tube box furnace. The new *short* Inconel radiant tubes make it practical. Because the tubes are short, space-saving vertical mounting along the sides of the furnace is possible. Because they are made of high hot-strength Inconel, tubes are thin and lightweight, transfer heat rapidly, give long trouble-free life.

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Materials Engineering File Facts

MATERIALS & METHODS
December • 1954
Number 291

Cast Aluminum Bronzes

Alloys of copper containing up to about 15% aluminum are called aluminum bronzes. Although there are numerous alloys fitting these requirements, the following are the most commonly used as castings. Aluminum bronzes have good resistance to corrosion in many environments. These properties lead to their use in the chemical process industries and marine applications. Their wear resistance and low coefficients of friction in contact with other metals are responsible for their selection for use in machine parts.

BBII Grade	9A	9B	9C	9D
COMPOSITION—%	Cu 87.5 Al 9 Fe 3.5	Cu 89 Al 10 Fe 1	Cu 83 min Al 10–11.5 Fe 3–5 Ni 2.5 max Mn 0.5 max	Cu 81 Al 11 Fe 4 Ni 4
PHYSICAL PROPERTIES				
Density, lb/cu in.	0.267	0.270	0.272	0.273
Melting (Point) Range F	—	1900	1910–1850	1937
Thermal Cond, Btu/hr/sq ft/ft/°F, at 68 F	—	33	—	22
Coeff of Exp per °F:	9.5×10^{-6}[a]	9.5×10^{-6}[b]	9.0×10^{-6}[b]	—
Elect. Res, microhm-cm at 68 F:	13	13.5	12	7.5
Magnetic Properties	← Non-Magnetic →			
MECHANICAL PROPERTIES				
Mod of Elasticity in Tension, psi	17×10^{6}	15×10^{6}	18×10^{6}	17×10^{6}
Tensile Str, 1000 psi:				
Sand Cast	75	67	75	95
Sand Cast and Heat Treated	—	90[c]	105[d]	115[e]
Yield Str, 0.5% extn, 1000 psi:				
Sand Cast	27	32	35	45
Sand Cast and Heat Treated	—	40[c]	52[d]	70[e]
Elongation in 2 in., %:				
Sand Cast	35	15	18	7
Sand Cast and Heat Treated	—	15[c]	10[d]	5[e]
Hardness, Bhn.:				
Sand Cast	120	140	155	195
Sand Cast and Heat Treated	—	180[c]	230[d]	235[e]
THERMAL TREATMENT				
Normalizing	Heat to 1500 F, furnace cool to 1000 F, air cool.			
Quenching Temp, F	1600–1700	1600–1700	1600–1700	1600–1700
Tempering Temp, F	700–1200	700–1200	700–1200	700–1200
FABRICATING PROPERTIES				
Casting	Because of narrow freezing ranges and high shrinkage, aluminum bronzes are difficult to cast. In addition they are sensitive to gases. In melting, precautions must be taken to minimize stirring and breaking the oxide skin on the surface of the melt to prevent absorption of gases. In pouring, agitation must be avoided and castings are generally bottom gated to reduce turbulence. Shrinkage difficulties are overcome by use of large risers, to feed the casting, and chills.			
Machinability Index (Free-Cutting Brass = 100)	20–30	20–30	20–30	20–30
Weldability:	Can be welded by carbon arc, inert gas arc and resistance methods; can be brazed with silver brazing alloys but require special fluxes.			
CORROSION RESISTANCE:	Generally good resistance to atmosphere, water and salt water, salt solutions. Some resistance to alkaline solutions and non-oxidizing inorganic acids. Poor resistance to ammonia compounds, ferric salts and oxidizing inorganic acids.			
USES	Machine parts, pump impellers and casings, gears, rolling mill bearing segments and washers, bearings, chemical plant equipment, pickling equipment such as chains and hooks, marine propellers pump casings, fittings.			

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[a] *70–250 F.*
[b] *70–500 F.*
[c] *Water-quenched from 1625 F, tempered 1125 F, water-quenched.*
[d] *Water-quenched from 1625 F, tempered 1000 F, water-quenched.*
[e] *Water-quenched from 1625 F, tempered 1150 F, water-quenched.*

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The Marlin Firearms Co., "Famous for Fine Guns since 1870", has long depended on Du-Lite black oxide for an attractive finish that will be dimensionally stable throughout the life of the gun.

The Du-Lite process provides intricate precision parts with a durable, rust-resistant black oxide finish. And since Du-Lite penetrates the metal, all crevices and knurls are protected without affecting dimensions or fit.

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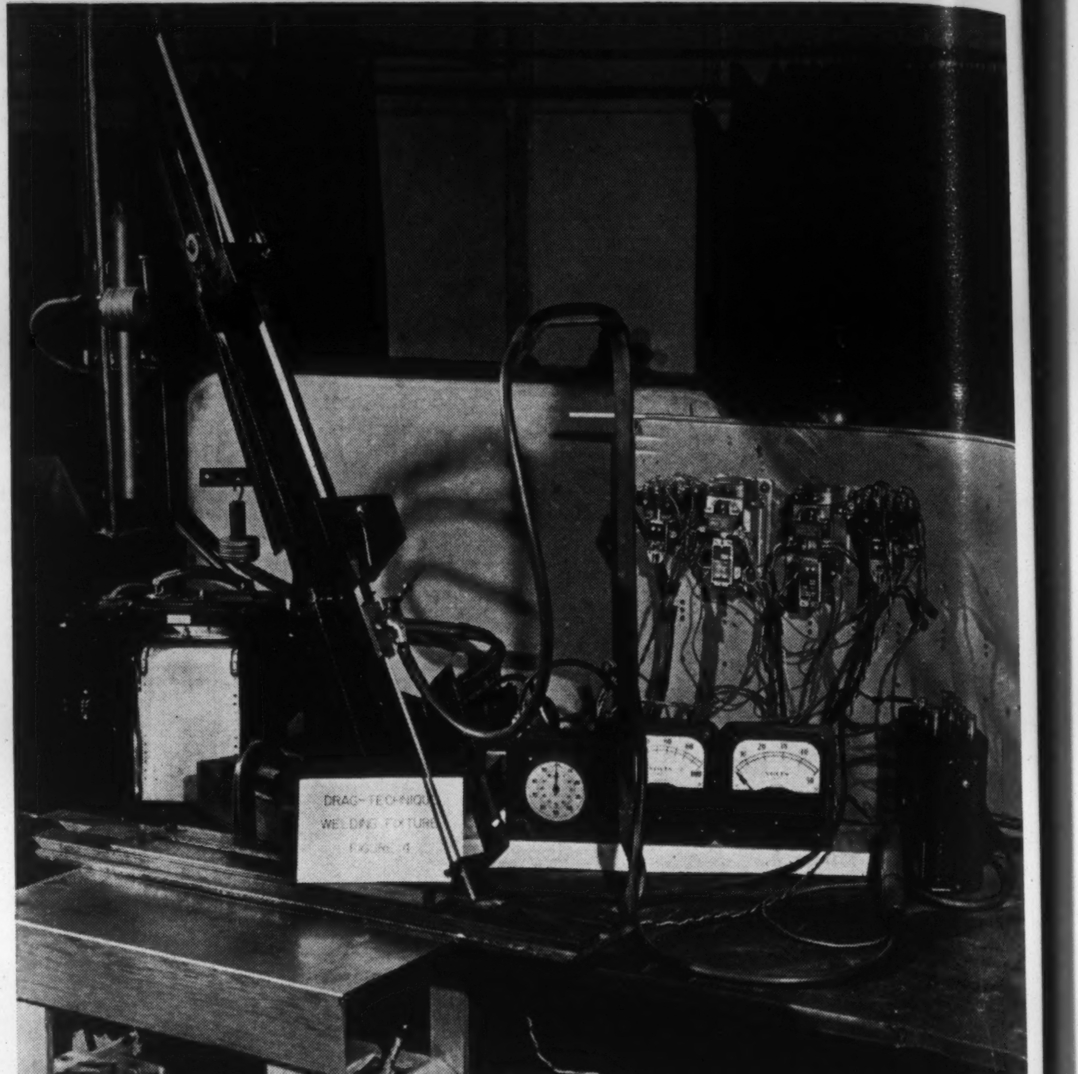

Simple testing rig consists of electrode feeder and travelling work table mounted on standard welding or cutting machine bed.

Two Performance Tests Select the Best Welding Electrodes

Electrodes of the same AWS classification vary in performance. Here is how one manufacturer solved his selection problem by a testing program tied to specific job applications.

by KENNETH ROSE, Mid-Western Editor, Materials & Methods

● EVEN THOUGH welding electrodes from different manufacturers have identical AWS classifications, their service performance is likely to vary. And the variation can have a considerable effect on production quality and production costs. A specific evaluation test, which duplicates the service conditions of the joining operation, is often the most satisfactory way to establish which brands of electrodes are most suitable for a given job.

Several years ago, Ford Motor Co. set up such a testing program for selecting electrodes for manual arc welding of chassis frames and body sheet-metal. On the basis of the tests, the company can estimate production costs and can order electrodes for production runs in large quantities.

Early in its program of developing the specific performance test, Ford discarded tests involving evaluations and trials by welders on the job, as it was impossible to establish criteria free from personal bias. To eliminate all possibilities of subjective error, they designed a simple rig which standardized the conditions of horizontal lap and vertical joint welds encountered in actual production runs. From the test results, the purchasing department can interpret the performance of each make, type, and size of electrode in direct terms of dollars per foot of weld.

Testing Device

In order to get significant results, the testing equipment provides controlled variable welding-speed, electrode pressure, and welding current. The final configuration of the tester was a simple extension bolted on a conventional welding or cutting machine to hold the specimen, and a mechanical electrode holder with a feed mechanism to force the electrode against the test piece at a predetermined constant load.

The testing machine operates at any given speed and current and provides direct measurement of the following important factors in electrode performance:

1. Length of acceptable joint per electrode.
2. Useable length of electrode (minimum stub length before breakdown of coating, arc instability, or sticking occurs).
3. Ability to fill behind the arc.
4. Effect of position of plates (horizontal or vertical).

While deposition-rate, deposition-efficiency and spatter-loss data are obtained, no significant conclusions in terms of production cost are drawn from them.

Frame Weld Test

In testing electrodes for joining frame members, the greatest differences appeared in horizontal fillet welding a lap joint with the plates in a vertical position. For testing, specimens of frame stock are assembled and spot welded to hold that position in the testing machine. The following factors provide adequate data for electrode selection and are recorded for each test:

1. Weld length in inches for 14-in. electrode under standard test conditions.
2. Ability to fill. This rating of weld continuity is adjudged "very good" to "poor" depending upon the number of holes, or separated weld-metal, per specimen. Top rating requires complete continuity, and a poor rating represents seven or more discontinuities.
3. Bead appearance. A flat bead with good adherence at both edges gets top rating. Undercut and/or poor contour are chief defects.
4. Stub length, or unuseable portion of electrode.
5. Percent shorting. Electrodes which fail before reaching minimum stub length.

For the frame welding test, Ford used 3/16-in. diameter electrodes of AWS classification E-6012. Early in the program, the 3/16-in. electrodes showed demonstrable superiority to the 5/32-in. size, and the smaller size was dropped from testing.

Sheet Welding Test

A very different type of drag electrode is required for welding steel sheet used in car bodies. Arc welding the 20-gage (0.036 in.) steel demands minimum penetration, maximum deposit, avoidance of sticking or sputtering, and easy starting. Welding experience established that arc-starting characteristics determine to a large extent the welding current used, as welders will increase current to abnormally high values to try to improve poor-starting electrodes. The high welding current, of course, has an adverse effect on penetration, weld quality, and deposition. Because arc-starting characteristics are so vital for sheet welding applications, starting tests are used as a first screening elimination for electrodes under test. Qualifying electrodes are then evaluated in the testing apparatus.

Seven standardized conditions were established for the mechanized test. They are:

1. Welding current: 180 amp.
2. Welding voltage: optimum for electrode type.
3. Axial load: 8 oz.
4. Position: inclined 53 deg from work plane, 20 deg from line of travel.
5. Speed: 50 in. per min.
6. Test piece: two lapping pieces of 20-gage body steel.
7. Tip cupped by manual strike before mounting in fixture.

Evaluation procedure consists of three tests.

A. Rapid restriking test. For determining the average minimum current for rapid skip welding without sputtering or sticking. Apparatus is modified to lift electrode ¾ in. and

(Continued on page 138)

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- SPECIAL SHAPES
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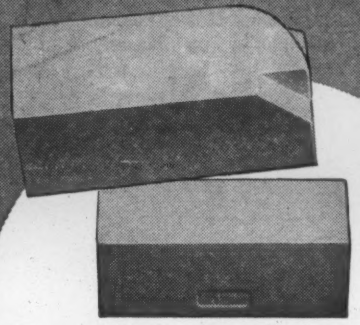

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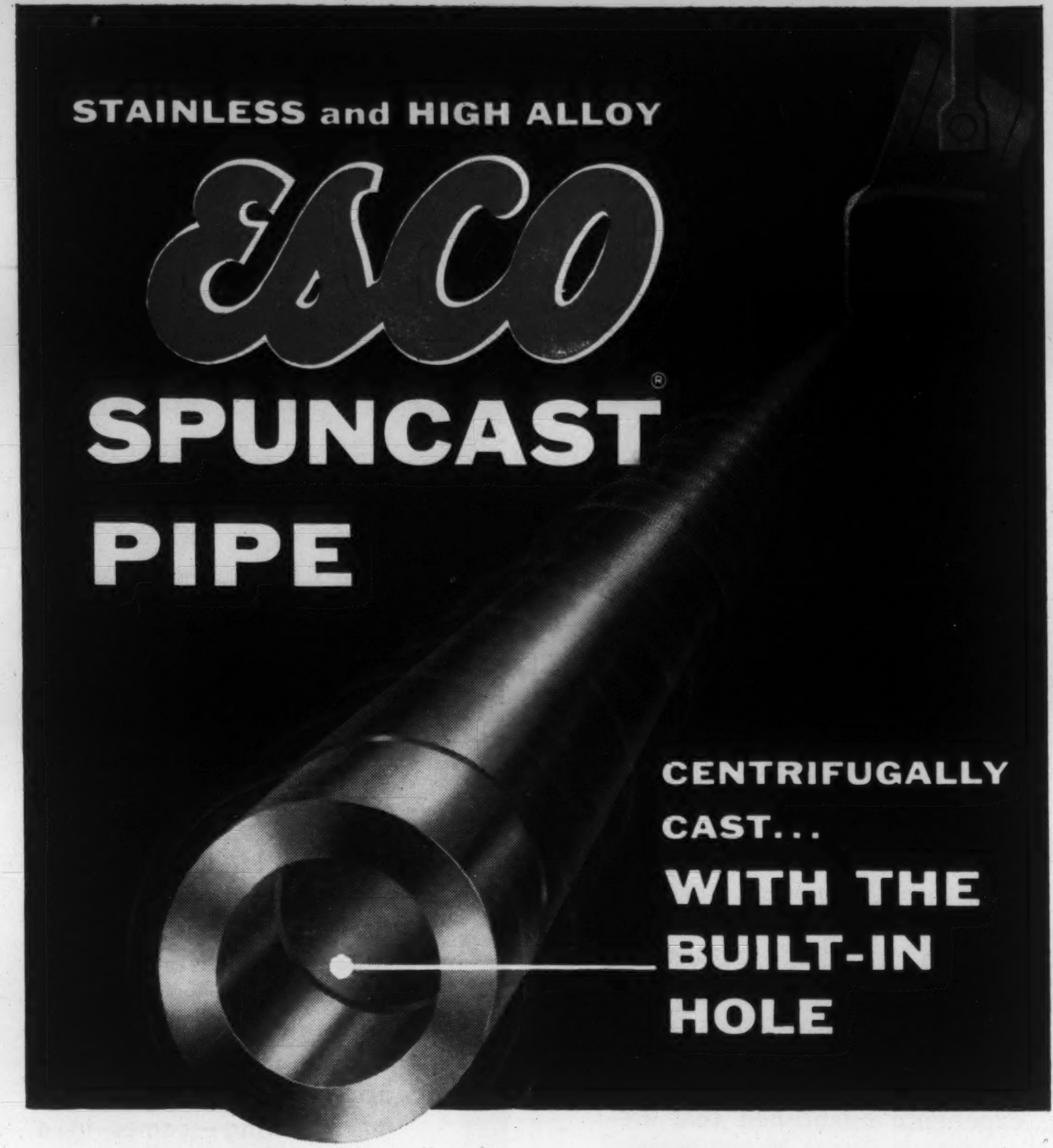

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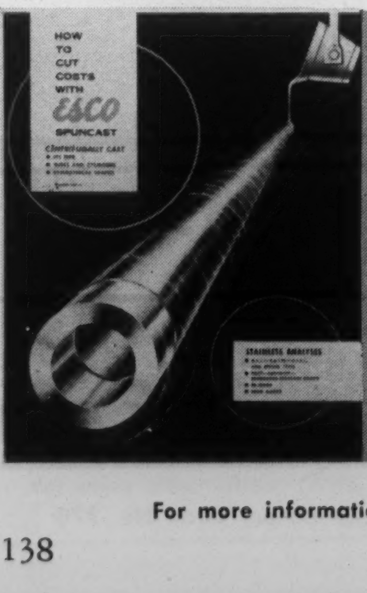

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continued from page 137

drop it to the work in a weld-skip cycle of one-inch welds, one-inch skips. Current is decreased until less than three welds in four cycles are full sized and uninterrupted. Conditions 2, 3, 4, 5, and 7 apply in this test.

B. Room temperature starting test. The test establishes the minimum drop height to establish conductivity. The electrode is dropped manually in the special testing device at 1/4-in. increments. Good electrodes should produce consistant starts from a drop height of less than 1/2 in. Conditions 1, 2, 3, 4, and 7, are imposed for this test.

C. Deposition and penetration test. All seven control conditions apply. Three sample welds are run on 19-in. lapped strips after preliminary trials establish the machine settings to produce proper current and speed as stated in conditions 1 and 5. Electrodes are graded by the following criteria: excessive penetration is indicated by holes burned through both strips in each of three samples; continuity of deposition is determined by adding length of sound welds, dividing by the total length of deposit and multiplying by 100 to get a percentage figure.

Use of Test Results

The tests serve to rate electrodes on a controlled, standardized basis, mechanized to the greatest possible extent, and give results directly related to production performance. In most cases the results are numerical, and in all cases are significant for the specific application. If necessary, results can be reduced to actual dollars per unit length of weld by evaluating the following variables: 1) Labor rate per hour, 2) Electrical rate per kilowatt, 3) Cost per stick of electrode, 4) Length of joint per electrode, 5) Optimum welding speed for electrode, 6) Time allowance for changing electrodes. The dollar and cents result gives a graphic picture of the effect of various electrodes on production costs.

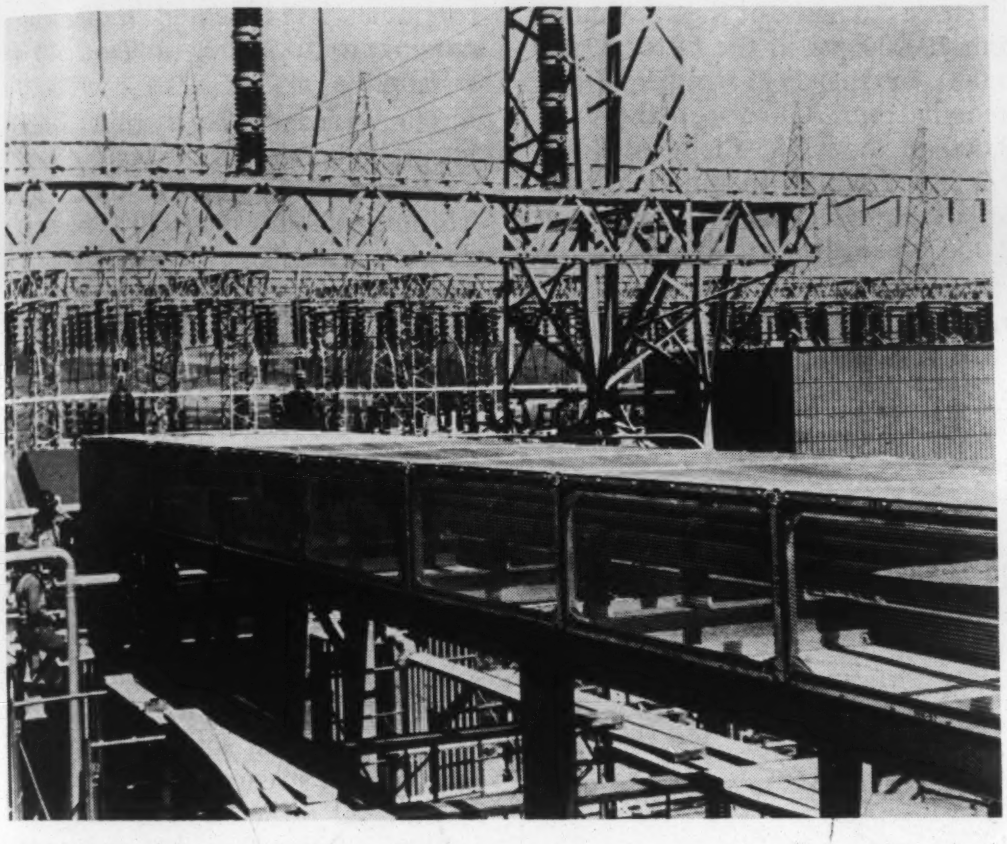
Coming in January

Next month M&M will present another in our series of manuals on copper alloys. It will discuss properties, fabrication and applications of the Wrought Non-leaded Brasses.

Look for Manual No. 112.

New Materials, Parts and Finishes

. . . and Related Equipment



Electrical busbars are covered with expanded aluminum cage to prevent electrocution of birds. (Penn Metal Co., Inc.)

New Aluminum Materials

- *Two Electrical Alloys*
- *Alloy for High Finish*
- *Clad Tubing*

Four new aluminum materials have recently been marketed for commercial use: two new electrical grade alloys possessing higher strength properties; an alloy which lends itself to all methods of finishing and after anodizing has particularly high reflectivity characteristics; and welded clad tubing particularly designed for irrigation use where the water is highly corrosive.

High Strength Electrical Alloys

Presently available only as rectangular and tubular bus, alloy No. 2EC-T8, developed by the *Aluminum Co. of America,* 1501 Alcoa Bldg., Pittsburgh 19, is said to have a minimum tensile yield strength of 25,000 psi and a minimum conductivity of 57% IACS. The compressive creep rate is said to be much better than EC alloys and tolerances for the new tubular bus are the same as those for drawn tube. Although No. 2EC alloy in the T8 temper has conductivity and yield strength balanced to meet the requirements of busway manufacturers, the producer is carrying out experimental work to allow the establishment of other standard tempers with definite characteristics.

The following table lists the minimum properties of the new 2EC-T8 along with those of other aluminum alloys commonly used for bus conductors.

	2EC-T8	EC-H17	6063-T6
Ten Str, psi	28,000	17,000	30,000
Yd Str, psi	25,000	15,000	25,000
Elect Cond, at 20 C, % IACS	57	61	51

The new electrical grade alloy 55EC produced by *Kaiser Aluminum & Chemical Corp.,* 1924 Broadway, Oakland 12, Cal., has slightly higher tensile strengths and slightly lower conductivity than the Alcoa alloy. The new alloy was developed to combine the high strength of 6063-T6 with conductivity approaching that of EC-H17. The producer expects it to find use in applications where short-circuit forces are high. The material is available in many structural shapes and in both rectangular and tubular conductors. According to the company, welding and plating characteristics are similar to other aluminum electrical alloys.

The following table lists the minimum properties of the new 55EC with those of other aluminum alloys which are commonly used for bus conductors.

	55EC	EC-H17	6063-T6
Ten Str, psi	29,000	17,000	32,000
Yd Str, psi	25,000	15,000	25,000
Elect Cond, at 20 C, % IACS	55	61	51

Alloy for High Surface Finish

Aluminum alloy 5357 is now available from *Kaiser Aluminum & Chemical Corp.,* 1924 Broadway, Oakland 12, Cal., for applications requiring an anodized finish similar to polished chromium plate and stainless steel. It lends itself to all mechanical, chemical and electro-chemical finishing procedures. After anodizing, it has particularly high reflective characteristics, said to be superior to those of the anodic coating obtained on 3003 and 3005. The high specular finish is also maintained in color anodizing.

The processing of parts made of the alloy follows customary practices used with other non-heat-treatable alloys. Forming characteristics are similar to those of 3003, although 5357 has slightly less elongation in the softer tempers. The alloy is readily welded by any of the common methods using filler materials of 5357, 4043, 5052, or 5056. It can also be brazed satisfactorily with filler metals of 716, 718 or 5056. Properties of the brazed joints will be similar to those of the parent metal in the annealed temper.

The alloy is available as flat sheet, coil and circles in the O, H32, H34, H36 and H38 tempers. Maximum width of the flat sheet is 72 in., and gage ranges from 0.006 to 0.249 in. Coil may be obtained up to 60 in. wide in gages from 0.006 to 0.125 in.

Tensile strengths of the alloy range from 19,000 psi in the O temper to 30,000 in the H38 temper; yield strength from 7000 psi in the O to 28,000 in the H38; Elongation (% in 2 in.) from 25 in the O to 6 in the H38; and shearing strength from 12,000 psi in the O to 18,000 in the H38.

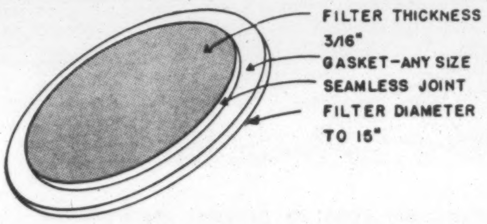
Welded Clad Tubing

Clad aluminum tubing, designed for irrigation use where the water is highly corrosive, is being produced by *Kaiser Aluminum & Chemical Corp.* The pipe is produced by the continuous weld method in diameters ranging from 2 to 5 in. and 40 ft in length.

The cladding is a thin lining integrally bonded in the rolling process to the aluminum alloy sheet from which the tubing is made. The cladding material gives the tubing increased resistance to the corrosion caused by chemical elements in the water.

Porous Teflon Aids Chemical Filtration and Dispersion

Teflon, DuPont's chemically inert, high temperature fluorocarbon plastic, is now available in porous form, marketed as Porous Teflon Filters by *Porous Plastic Filter Co.,* Glen Cove, N. Y. The filters are available in diameters up to 15 in. The mean pore size of the material is 9 microns which will filter out of liquids all particles having diameters larger than 3 microns. In gas filtration, all particles as small as one micron will be removed. Flow capacities up to 45 gal per min per sq ft of filter at 5 psi differential pressure can be anticipated for organic fluids of 1 cps viscosity.



The porous fluorocarbon plastic has a mean pore size of 9 microns.

The porous material is formed by sintering and molding without the aid of any additives or plasticizers, and is said to retain all the high corrosion and temperature resistance of solid Teflon. It is available in disc form in sizes up to 12 in. in diameter with a solid Teflon rim for high tear strengths and providing for integral gasketed mounting.

Porous Teflon is said to make possible the filtration and dispersion of all liquids and gases and is suitable for use with all commercial acids, caustics and organic solvents including fuming nitric acid, Aqua Regia and hydrogen peroxide. It can be chemically cleaned and sterilized, is non-absorbent, shows no strength loss when wet and is suitable for use up to 450 F.

New Silicate Coatings Protect Ferrous Metals

A new line of silicate or glass-like protective coatings which can be fused to any ferrous metal at moderate temperatures is being marketed by *Allied Porcenell, Inc.,* 851 S. Market St., Waukegan, Ill. Inorganic in composition, the Porcenells are not subject to corrosion or organic change and are said to provide permanent and decorative protection against rusting and corrosion.

Developed by Vitreco, Inc., a research company jointly owned by Poor & Co. and Youngstown Sheet & Tube Co., the silicates are said to be ageless, fireproof, possess good scratch resistance, permanent color and will not react to any corrosive agent normally found in the atmosphere.

The coatings can be applied by spray, brush or dipping and fired at 900 to 1200 F, depending on the type of finish desired. Porcenell coatings are similar to porcelain enamel, but are said to be less expensive due to the low firing temperatures required. Surfaces which can be coated include cast, wrought and malleable iron as well as high carbon steels.

Available in a variety of colors and in textures ranging from full matte to high gloss, a single coat is said to offer sufficient protection for most protective or decorative applications. Typical applications include those found in the electrical, appliance, architectural and transportation industries. It is said to be particularly adaptable for use on tank and tubular products.

Barrel Nickel Plating Gives Fully-Bright Deposits

An improved nickel plating process for barrel electroplating is said to produce fully-bright, ductile white deposits with low stress. Developed by *Hanson-Van Winkle-Munning Co.*, Matawan, N. J., the plating solution is said to be stable over long periods, and deposits require no activation prior to chromium plating.

Called Nickel-Lume Barrel Plating, the deposition can be carried on over a temperature range of 75 to 120 F with no loss in brightness. Voltage range is 8 to 10, and rate of deposition is said to run up to 0.0002 in. in 30 min, depending on the installation. The pH value falls between 3.5 and 4.2. Solutions are made up of nickel sulfate (200 lb per 100 gal), nickel chloride (37.5 lb per 100 gal), boric acid (31.2 lb per 100 gal), NL-1 brightener (5.0 lb per 100 gal) and NL-2 brightener (30.0 lb per 100 gal).

Continuous filtration is not required, but periodic filtration through filter-aid material is suggested. Bath purification is usually unnecessary but if organic or inorganic types of contamination reach abnormally high levels, such treatment may be used without harmful effect on the bath.

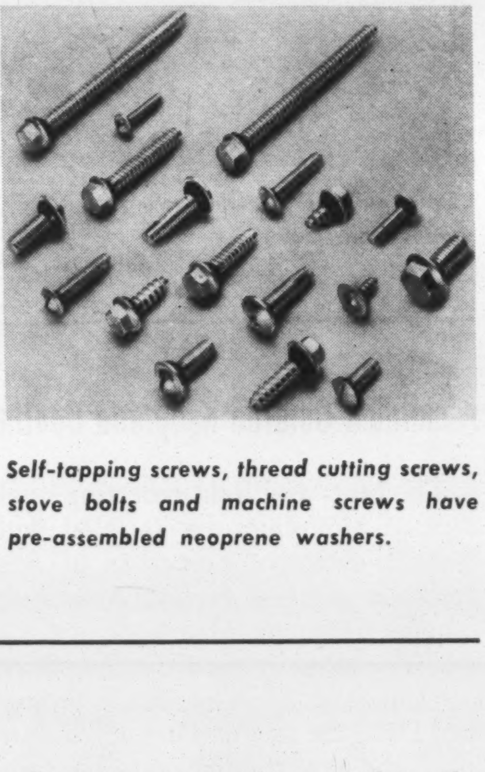
Process produces white, ductile and fully bright deposits.

Neoprene Adds Tight Seal to Fasteners

A new multi-purpose fastener with a one-piece metal washer-head and assembled neoprene washer has been developed for use in preventing leaks, protecting surfaces, absorbing shocks and stopping squeaks. When the fastener is seated, an undercut in the washer head traps and controls the flow of neoprene at the outside edge, forming a water- and air-tight seal.

Produced by the *Townsend Co.*, New Brighton, Pa., the Tuff-Tite fasteners are available in stainless, carbon and alloy steels as well as in the non-ferrous metals such as aluminum and copper. The fasteners may be applied on flat, concave or convex surfaces since the neoprene flows to conform to the surface contour.

Neoprene resists abrasion, sunlight, aging, ozone and heat, and performs effectively in temperatures ranging from –65 to 250 F. It will also retard electrolysis between dissimilar metals by insulating against direct contact. The fasteners are said to be well suited for applications where electrolysis, heat or electrical contact pose problems. The high dielectric properties of neoprene also make Tuff-Tite fasteners useful in the radio, television and electronic fields.



Self-tapping screws, thread cutting screws, stove bolts and machine screws have pre-assembled neoprene washers.

Asbestos and Glass Form New Insulation Tape

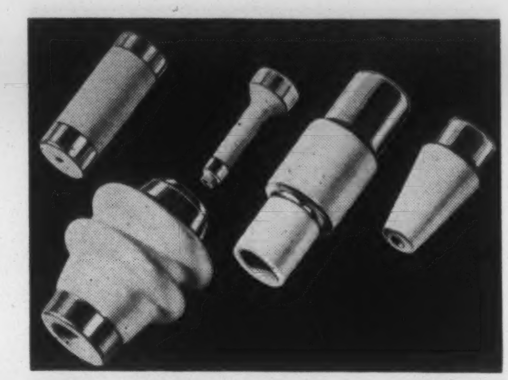
Six new tapes, coupling in various combinations the properties of glass fibers, asbestos and asphalt, have been developed by *Raybestos-Manhattan, Inc.*, Manheim, Pa. The combinations are said to provide high strength, and resistance to temperatures and rot in cable insulation.

Novabestos No. 7503 is designed for use in the belt or fire wall of shipboard cables. The glass reinforcing yarns provide a tensile strength of 95 lb per in. of width, enabling the cable manufacturer to operate taping heads at maximum tension in binding together the components of the cable.

Novabestos No. 7504 is designed for use as primary insulation over bare conductor in shipboard cables. Its strength is adequate for this use, but it is not recommended for use as a belt. It may be used as strap insulation in winding transformer coils.

Novabestos No. 7505 is an asphalt impregnated tape for use primarily in AVA and AVC type cables. The combination of asphalt, asbestos and glass is said to provide good rot resistance. It enables the designer to provide a saturated wall, using taping heads, and to more nearly complete the cable in one operation.

Pyrotex Nos. 9519, 9520 and 9521 are tapes consisting of two layers of asbestos felt interspersed with layers of glass cloth. They are designed for essentially the same purposes as the Novabestos. The glass fiber filling yarns strengthen the tapes both lengthwise and crosswise and will reduce lengthwise cracks produced by the Navy's cold bend test for taped insulation. The tapes can be applied with any amount of register without cracking the edges.

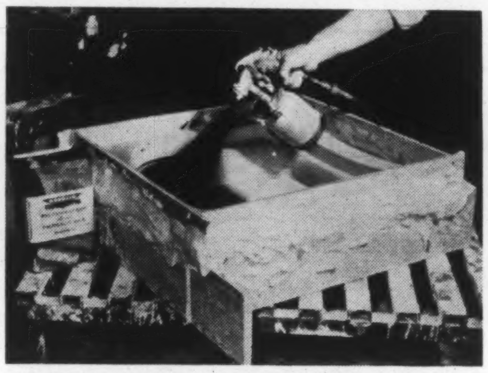


Metal coating eliminates intermediate plating treatments.

Metallized Ceramics Aid Soldering

Refractory glazed or bisque ceramic bodies can now be coated with a single metallic coating, to which both hard and soft solders can be applied to form vacuum-tight joints. The new metallizing process is said to eliminate the need for intermediate and expensive plating treatments. Developed by *Frenchtown Porcelain Co.*, 84 Muirhead Ave., Trenton, N. J., the metallized coating will take either hard solders melting in the range of 1000 to 1600 F or soft solders melting at 245 to 450 F.

It is recommended for use in the manufacture of mechanical, electrical and electronic seals; tube socket bases; switch stators and rotors; capacitor rotors and shaft; strain, spreader and pillar insulators and stand-offs; terminals; coil forms and similar components.



Coating allows smooth parting of epoxy shapes from molds.

New Release Agent Frees Epoxies From Mold

A new release agent, called PrEpoxy Partingkote 832-A, has been developed by *Rezolin, Inc.*, 5736 W. 96th St., Los Angeles Due to the high adhesive qualities of epoxy resins a careful application of a good release agent is essential for smooth parting of castings or laminates from the mold.

The new material has been formulated particularly for epoxy casting or laminating, room temperature curing resins. It is a film-forming, low-shrink plastic solution which is black in color, and which aids in applying a uniform coating to the mold. It is supplied ready to use, and may be sprayed or brushed onto plaster, wood, plastic or metallic molds. The material is supplied in quart, gallon, 5-gal and 55-gal quantities.

Aluminum Colored Neoprene Coating

The heat- and light-reflecting qualities of aluminum are coupled with the anti-corrosive properties of neoprene in GACO N-700 Aluminum Liquid Neoprene Maintenance Coating. Produced by the *Gates Engineering Co.*, 100 S. West St., Wilmington, Del., the aluminum colored coating is the newest addition to the company's line of gray and slate colored neoprene coatings.

The material is thermosetting, and will not soften, run or crack under heat. It is recommended for coating chemical process equipment, tanks, ducts and any metal, wood or concrete structures where corrosion protection is required. Since the aluminum coating will discolor in the presence of acid halides, it is not recommended for use in the presence of these agents, though the discoloration will not affect the protective properties of the material. It may be applied by brush, roller, dip or spray, and is sold in quart, gallon, 5-gal and 50-gal containers.

Adhesive-Coated Copper Foil For Printed Circuits

A new adhesive-coated copper foil is said to provide controlled thickness, uniform adhesive at glue line and simplified construction in printed circuit manufacture. Produced by the *Permacel Corp.*, New Brunswick, N. J., and designated P 195, the material (after cure) is said to resist solder at 410 F for 10 sec.

A one-ounce electrolytic copper foil coated with a thermosetting adhesive in dry film form, P 195 can be laminated to materials such as steel, brass, bronze aluminum, wood and phenolics. Lamination is accomplished at pressures of 100 to 2000 psi at 325 to 350 F for 10 to 20 min. It is designed for printed circuit uses in radios, hearing aids, television and other electrical and electronic applications where miniaturization is desired.

(More New Materials on page 146)

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—specialists in flat-rolled steel products for over 25 years.

**Make it WEIGH LESS . . .
and LAST
LONGER
with N·A·X
HIGH-TENSILE STEEL**

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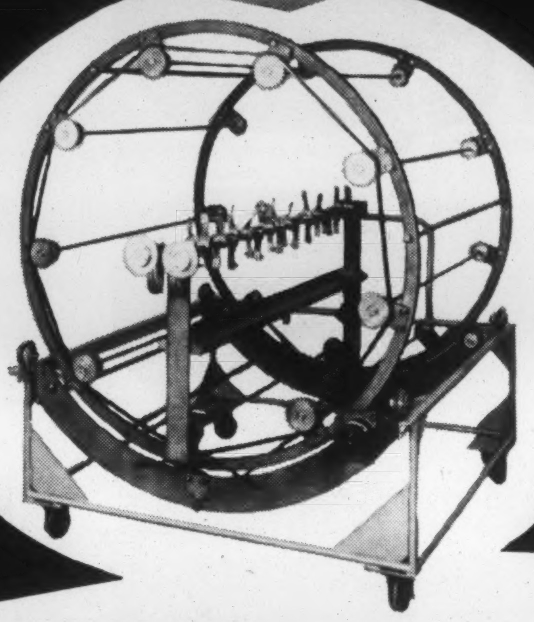
N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

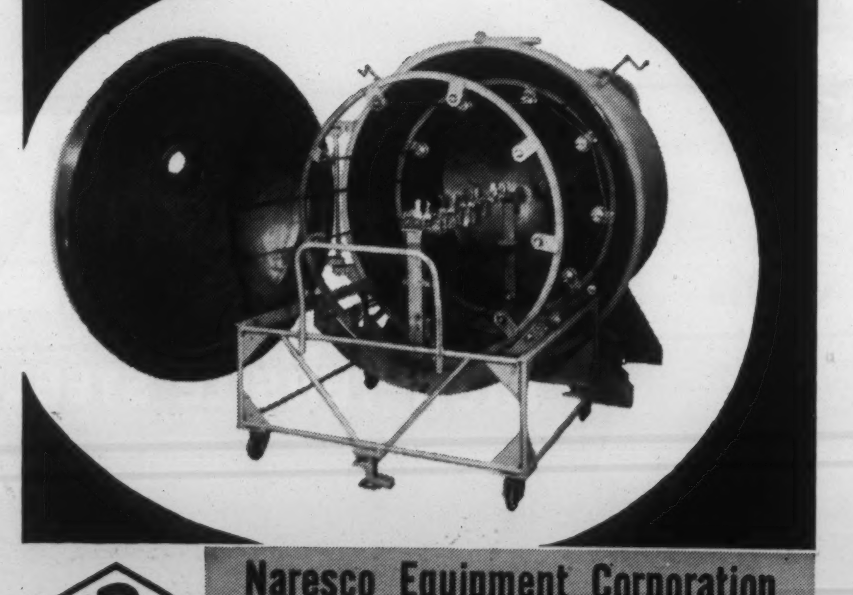
For more information, turn to Reader Service Card, Circle No. 309

NEW "PLANETARY" JIG
on NRC VACUUM COATERS
speeds production
produces better coating



- Eliminates "shadows"
- Prevents drip spoilages
- Reduces outgassing area
- Gives new ease of loading and handling
- Increases useful coating area
- Permits "boat" evaporation

The NRC "planetary" jig provides simultaneous rotation of rods *and* jig ... maximum loading capacity ... new ruggedness. Production is faster and rejects are far fewer. Write for information on the complete line of NRC vacuum coaters.



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Equipment Sales Subsidiary of
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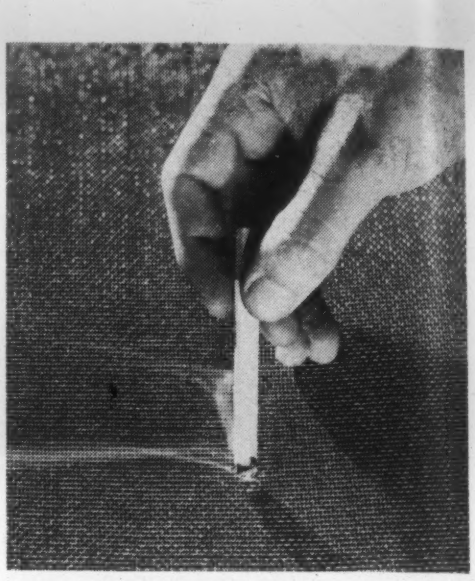
For more information, turn to Reader Service Card, Circle No. 423

New Materials, Parts and Finishes



Vinyl coated glass yarn insect screening resists heat.

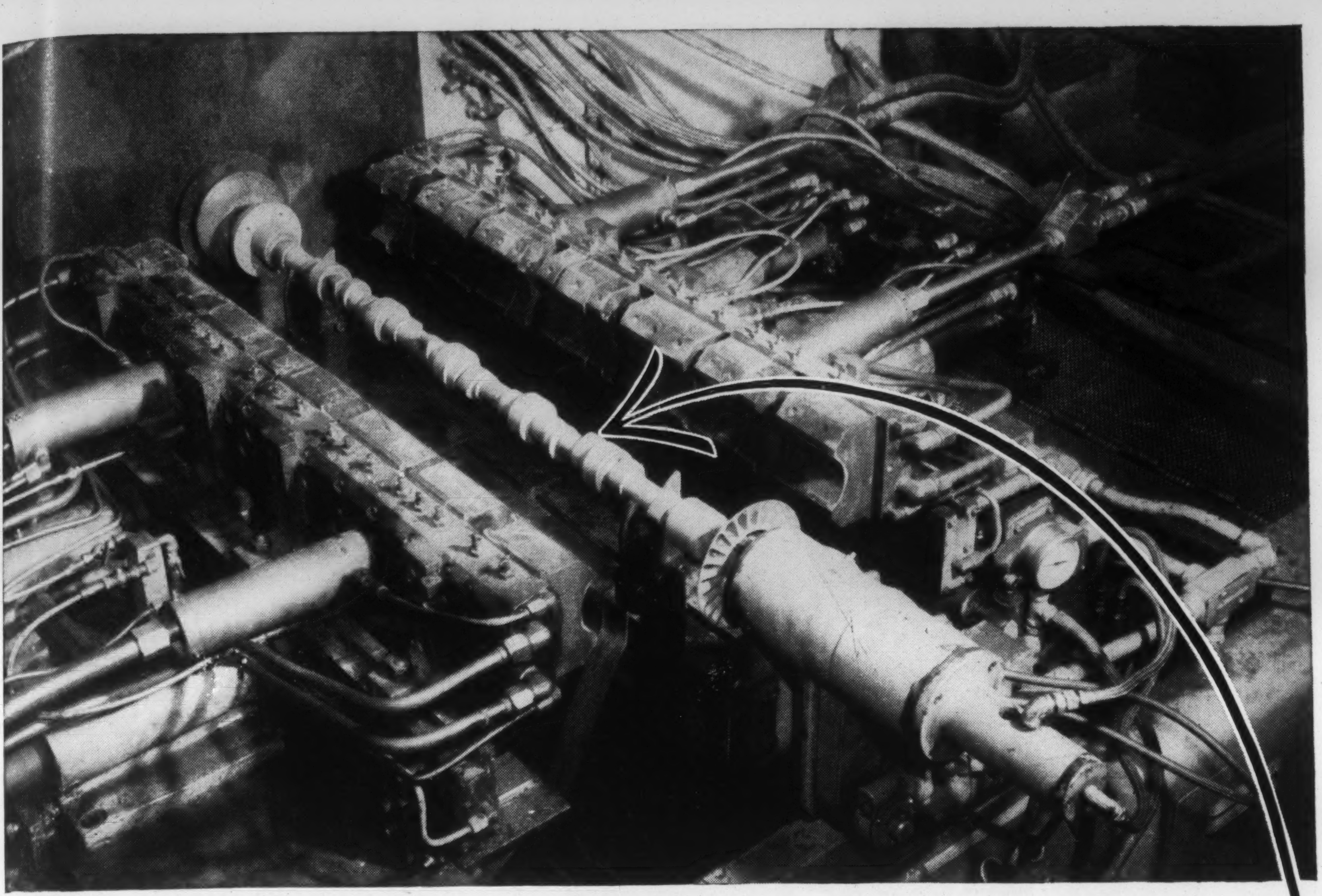
Plastics Coated Yarns Guard Wire and Cable

Any natural, or synthetic yarns, particularly glass fiber yarns, are now available in any count size, both single and plied with a uniform coating of vinyl, silicone, silicone rubber, Teflon, nylon, latex and other similar materials. The coated yarns, marketed by *Chemo-Textiles, Inc.,* Crompton, West Warwick, R. I., are recommended for various types of insulation for wires and cables. The line of insulation offers a variety of properties, including electrical and chemical as well as high heat resistance.

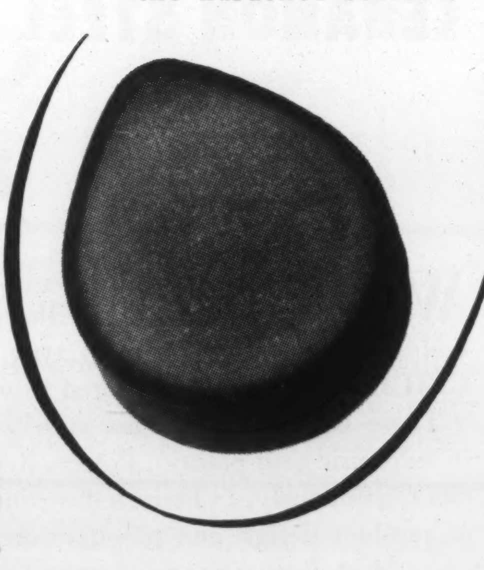
The coatings can be applied in wall thicknesses and compositions to suit specific needs. A variety of colors is available.

New Silicone Rubber Gums Give Higher Tear, Tensile Strengths

Two new gums for the manufacture of silicone rubber compounds with approximately double the strength of previously available materials have been developed by the *Silicone Products Dept., General Electric Co.,* Pittsfield, Mass. When used in combination with DuPont's silica reinforcement, silicone rubber compounds produced from the gums are said to have tear strengths of 200 to 300 lb per in., and tensile



A cross-section view of this camshaft shows an even, uniform depth of the hardened surface.



Automatic Flame-Hardening Boosts Production 300%

Using an automatic oxy-acetylene flame-hardening machine, a leading manufacturer of trucks and marine equipment increased the production of flame-hardened gears, bearings, and camshafts 300 per cent. Parts are flame-hardened on as many as 22 different surfaces in fast, simple operations.

The flame-hardening process produces wear-resistant surfaces on large and small sections without heating the entire part . . . Distortion is at a minimum, and case depth is easily and accurately controlled. Flame-hardening is fast and relatively simple compared with other methods of hardening metal such as nitriding and carburizing. Low cost, portable flame-hardening equipment is available for the majority of applications.

Your local LINDE representative will be glad to show you how to produce machine parts with a tough, ductile interior and a hard, wear-resistant surface. Start saving now, call him for more information on flame-hardening.

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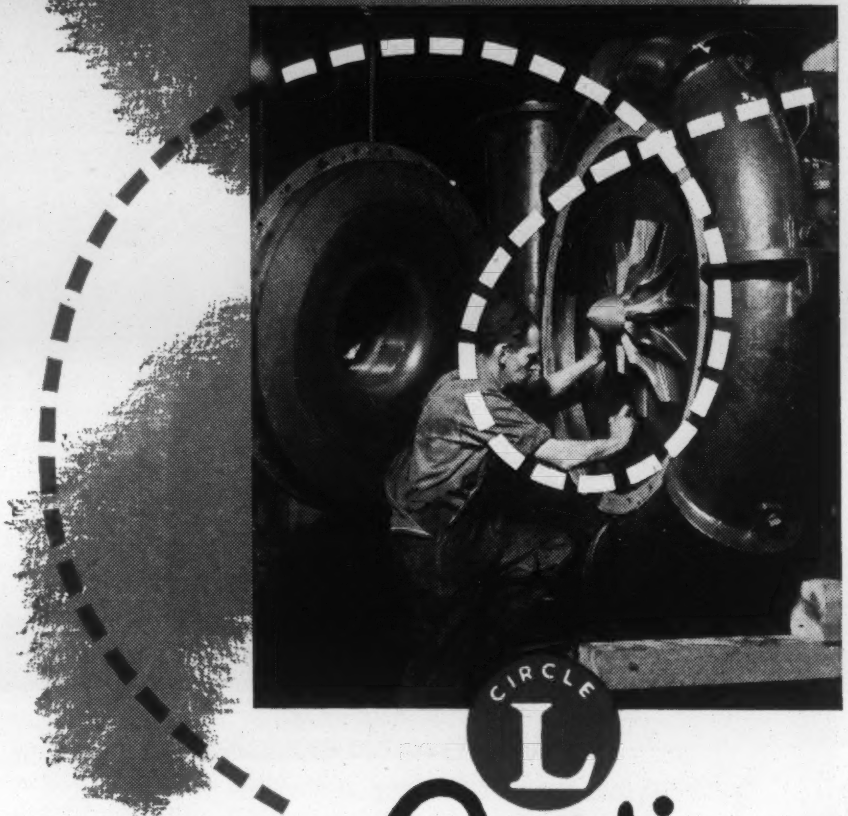
For more information, turn to Reader Service Card, Circle No. 412



IN THE CENTER OF A

Miniature tornado

LEBANON STEEL Castings are at work

WHIPPING up a wind as high as 120 mph is the job of Elliott Company's Single-Stage Centrifugal Blowers. In these blowers the "tornado-builder" is a one-piece, open type, radial-bladed impeller—a Lebanon CIRCLE Ⓛ casting engineered to withstand unusual service conditions.

These Elliott Blowers are widely used by the Chemical (particularly in sulphuric acid plants), Power, Refining and Gas industries where they run continuously, 24 hours a day. Such difficult service requires excellence of product design and manufacture, for a stopped blower can mean a plant shut-down. That Lebanon CIRCLE Ⓛ castings are specified by Elliott is recognition, we believe, of the superior workmanship that is traditional with Lebanon Steel Foundry craftsmen.

See—STEEL WITH A THOUSAND QUALITIES—37-min., 16 mm, full-color, sound film on the making of steel castings. For information write: Dept. D, Lebanon Steel Foundry.

LEBANON Castings

CARBON, SPECIAL ALLOY AND STAINLESS STEEL

CIRCLE L

LEBANON STEEL FOUNDRY LEBANON, PA.

For more information, turn to Reader Service Card, Circle No. 329

New Materials, Parts and Finishes

strengths of around 1600 psi. Elongation is said to be improved by about 50%.

Designated No. 81465 and 81477, the gums though commercially available, are still in the developmental stage and are being subjected to improvements to permit more efficient use with the silica filler. G-E 81465 gum has normal shrinkage and flexiblity at –65 F, while G-E 81477 has lower shrinkage and retains flexibility below –100 F. The latter is said to be particularly adapted to the needs of the aircraft industry.

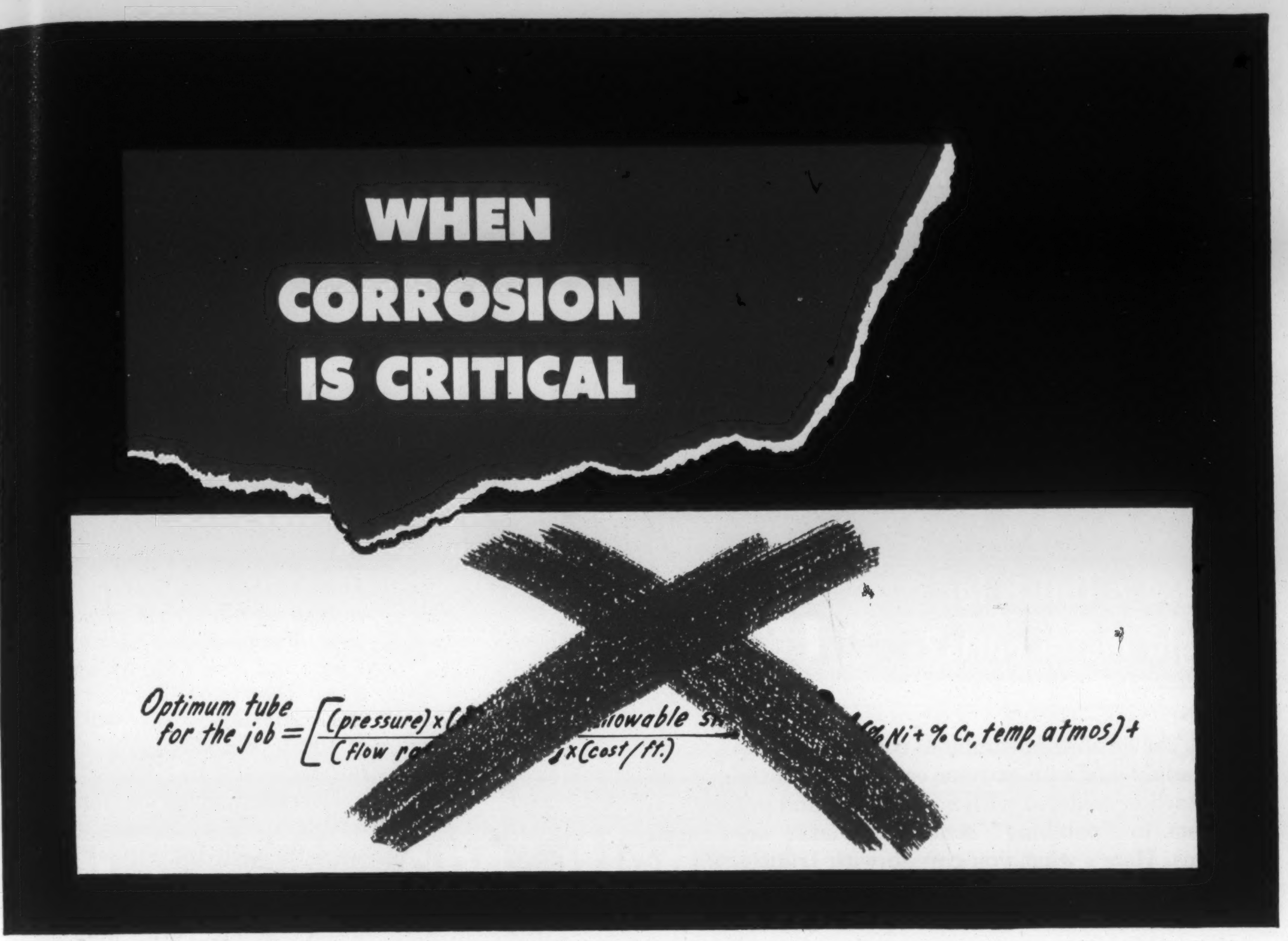
New Epoxy Patching Paste With Aluminum Filler

A new paste-like epoxy patching resin, Epocast H-783-A, has been marketed by *Furane Plastics, Inc.*, 4516 Brazil St., Los Angeles 39. The material contains aluminum powder filler and is designed for rapid repair or build-up on both plastics and metal structures. Ten to twelve per cent Hardener HN-23 is added before application, and the mixture cures at room temperature in 30 to 90 min, depending on the thickness. After hardening it may be sanded or filed to the desired contour. Epocast H-783-A offers a good bond to metals, negligible shrinkage and is adaptable as a quick-setting repair paste for metals, wood, glass and ceramics.

Wide Glass Mats Have Good Formability

Use of the good forming and draping characteristics of mechanically bonded glass mats will be broadened by the production of larger mats, 84 in. wide. They are available from *Bigelow Fiber Glass Products, Div. of Bigelow-Sanford Carpet Co., Inc.*, 140 Madison Ave., New York 16, in untextured grades or textured for matched metal die molding. Weights run from 2 to 7 oz per sq ft, with heavier weights available on special order.

(More New Materials on page 150)


WHEN
CORROSION
IS CRITICAL
Optimum tube for the job = [(pressure)×(... allowable st... / (flow r...)×(cost/ft.) ... %Ni + % Cr, temp, atmos) +

Tube Selection Cannot be Reduced to a Formula

—even a complicated one

Selection of the proper grade of stainless steel for a particular application is a relatively complex problem and involves manufacturing, metallurgical, chemical and economic considerations. Although it is complex it has been made easier by industrial research. Data accumulated through years of research and experience gained in helping to solve varied application problems are now available to guide the user in the solution of his present problems.

It is practically impossible to list all the media in which stainless steels will resist corrosion. It is even more difficult to enumerate all the conditions under which the stainless steels will resist effectively the corrosive effects of such media. Frequently, a relatively minor contaminant, when combined with the main reagent, will cause a more detrimental corrosive action than the latter by itself. This is particularly true of iron salts which, in the presence of chlorides, often prove to be a very potent corrodent, producing pitting.

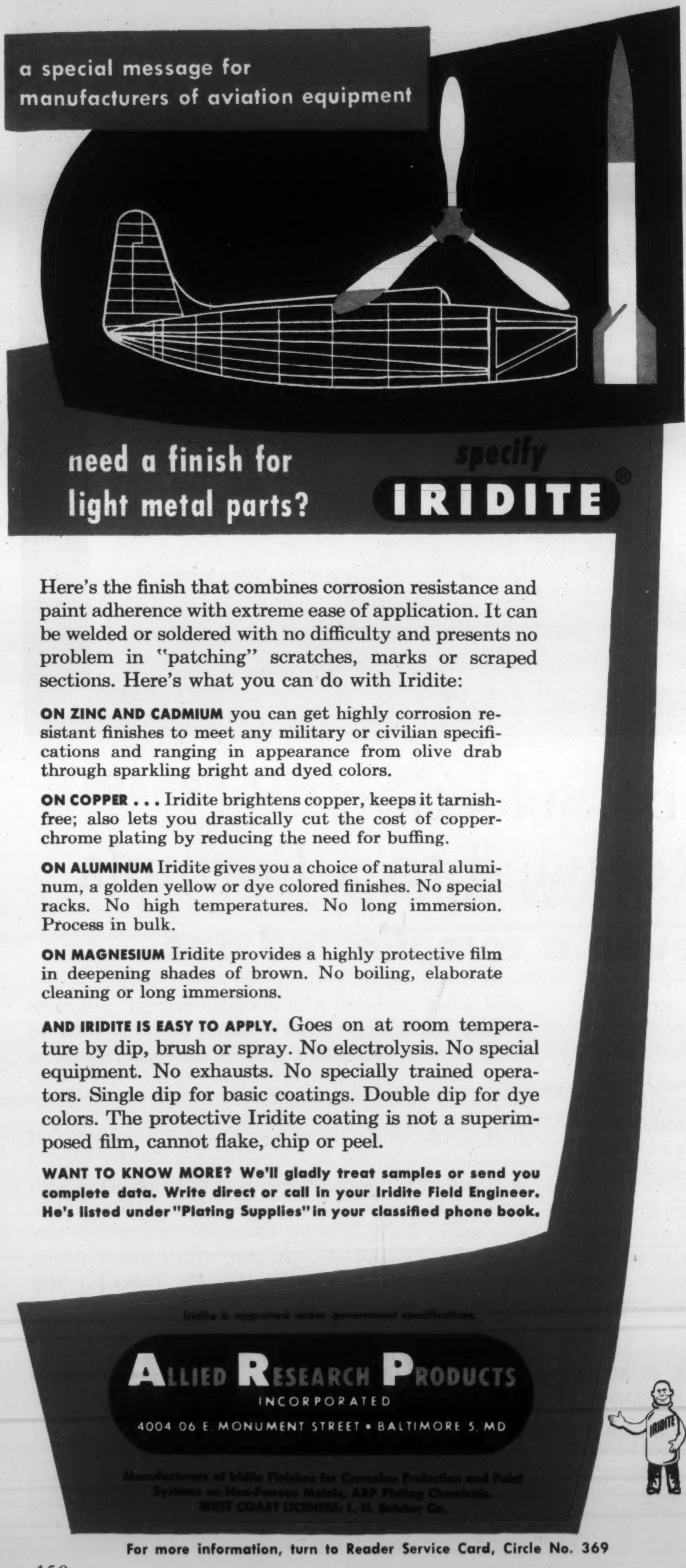
It is always advisable to test a sample under actual operating conditions, especially before extensive untried installations are made. Proper tube selection starts with expert opinion, available to you through Mr. Tubes, your nearby B&W Tube Representative. There is no substitute for the kind of experience with pressure tubing problems you'll find at B&W. Ask Mr. Tubes for help in matching tubes to jobs.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

B&W SEAMLESS and WELDED TUBES

TA-4061(P)

For more information, turn to Reader Service Card, Circle No. 315


a special message for manufacturers of aviation equipment

need a finish for light metal parts? specify IRIDITE®

Here's the finish that combines corrosion resistance and paint adherence with extreme ease of application. It can be welded or soldered with no difficulty and presents no problem in "patching" scratches, marks or scraped sections. Here's what you can do with Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified phone book.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, ARP Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.

For more information, turn to Reader Service Card, Circle No. 369

New Materials, Parts and Finishes

Tape Aids Bag Molding of Plastics

A new sealing tape known as No. 579.6 Polyvinyl Film Sealer has been developed to replace metal forms, gaskets, rings and C clamps in hermetically sealing the polyvinyl alcohol blanket or bag in vacuum bag molding of polyester-glass fiber laminates. Produced by *Presstite Engineering Co.,* 3798 Chouteau Ave., St. Louis 10, Mo., the tape is extruded in ribbons or beads, has pressure-sensitive adhesion and is said to provide a tight seal during the forming operations. The tape is light green, odorless, permanently soft, will not flow at 300 F, is non-staining, non-bleeding, and non toxic.

Developed especially for the aircraft and plastics industry, the sealer has been used for various purposes such as sealing the plexiglas inspection window to the body of a guided missile casting. Now, with the increasing number of aircraft parts being molded in reinforced plastics, the tape is finding wide use in the molding process.

New Welding, Brazing and Soldering Materials

Several new metal-joining materials have been developed recently. These include general purpose welding electrodes, hard facing materials, brazing fluxes and soldering pastes.

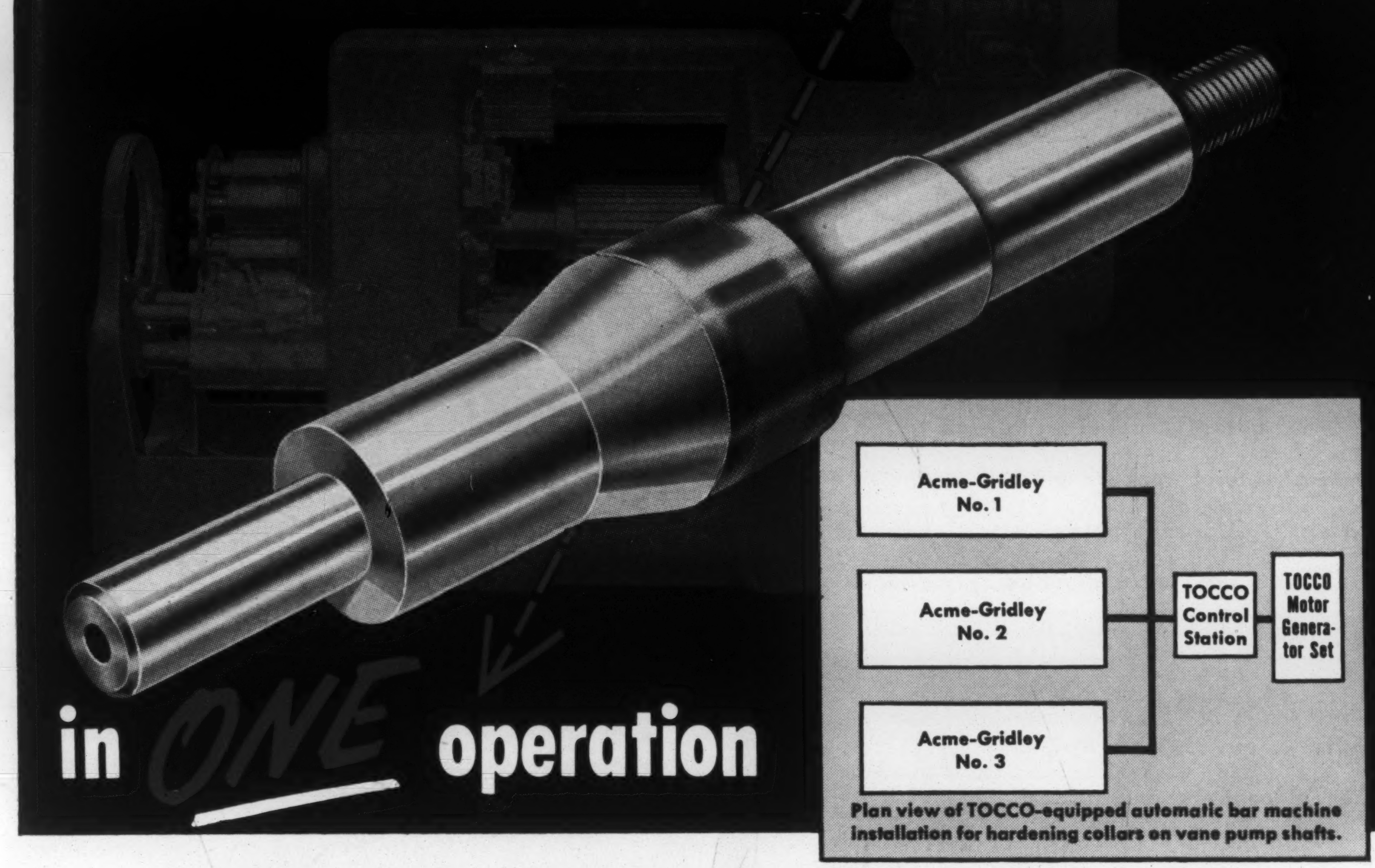
All-Purpose Electrode

A general purpose electrode, Sureweld CE, has been developed by *National Cylinder Gas Co.,* 840 N. Michigan Ave., Chicago, Ill., for welding mild steel. According to the company, field tests show the electrode can be used easily in all positions over a wide current range, and forms an easily removable slag. It is said to give a high rate of deposition with little spatter, resulting in beads of uniform appearance and even ripple.

It is classed as an AWS E-6010 rod. Tensile strengths of deposits are said to range from 75,000 to 85,000 psi. It conforms to specs of the principal codes for welding boilers and pressure vessels.

(Continued on page 152)

Pump Shafts Machined and Hardened



Plan view of TOCCO-equipped automatic bar machine installation for hardening collars on vane pump shafts.

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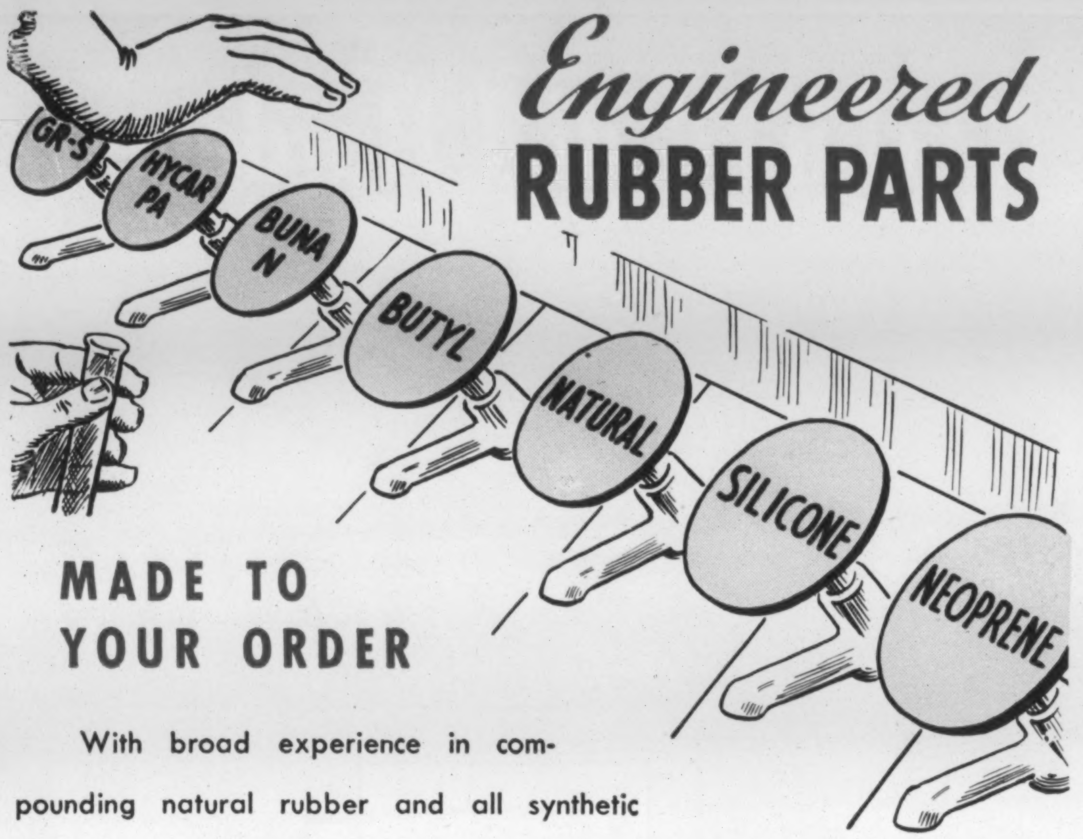

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New Materials, Parts and Finishes

Monel Rod Speeds Welding

Fast rate of deposition, uniform bead, easy slag removal and smooth arcs are claimed for a new monel electrode developed by *Pacific Welding Alloys Mfg. Co.*, 310 North Ave. 21, Los Angeles 31. Called Pacific Monel, the electrode is recommended for arc welding of monel to monel, monel to steel and nickel to steel. It is an all-position electrode, and has a uniform flux coating for application by a.c. or d.c. equipment.

Manganese Bronze Electrode

A covered manganese bronze electrode has been developed for high speed metal-arc welding of manganese bronze and yellow brass castings, sheet and plate Produced by *Ampco Metal, Inc.*, 1745 S. 38th St., Milwaukee 46, Mang-Trode rods operate at relatively high current densities on reverse polarity d.c. Arc action is said to be smooth and spatter loss low. The electrode can be used at room temperature without excessive preheat and interpass temperatures. Deposit composition, mechanical properties and color match those of manganese bronze, according to the manufacturer.

New Line of Wire Electrodes

An improved line of automatic wire electrodes with diameter tolerances held to 0.001 in. has been developed by the *Mir-O-Col Alloy Co., Inc.*, 312 North Ave. 21, Los Angeles 31. The wire is firm and will not crush during feeding. Annealed and layer wound in 100-lb coils the automatic wire is said to be particularly suitable for use where a number of similar parts are to be rebuilt or where considerable material is to be applied to a single part. All Mir-O-Col wire can be operated on a.c. or d.c., with submerged arc as well as other automatic methods.

Two Hard-Facing Rods

Two companies have recently developed new hard-facing materials; one is a chromium-cobalt-tungsten rod, the other a chromium-manganese-nickel electrode.

Walloy No. 6 is a chromium-cobalt-tungsten hard-facing rod for oxyacetylene torch application. Produced by *Wall Colmonoy Corp.*, 19345 John R St, Detroit 3, the rod is designed for general applications where wear and

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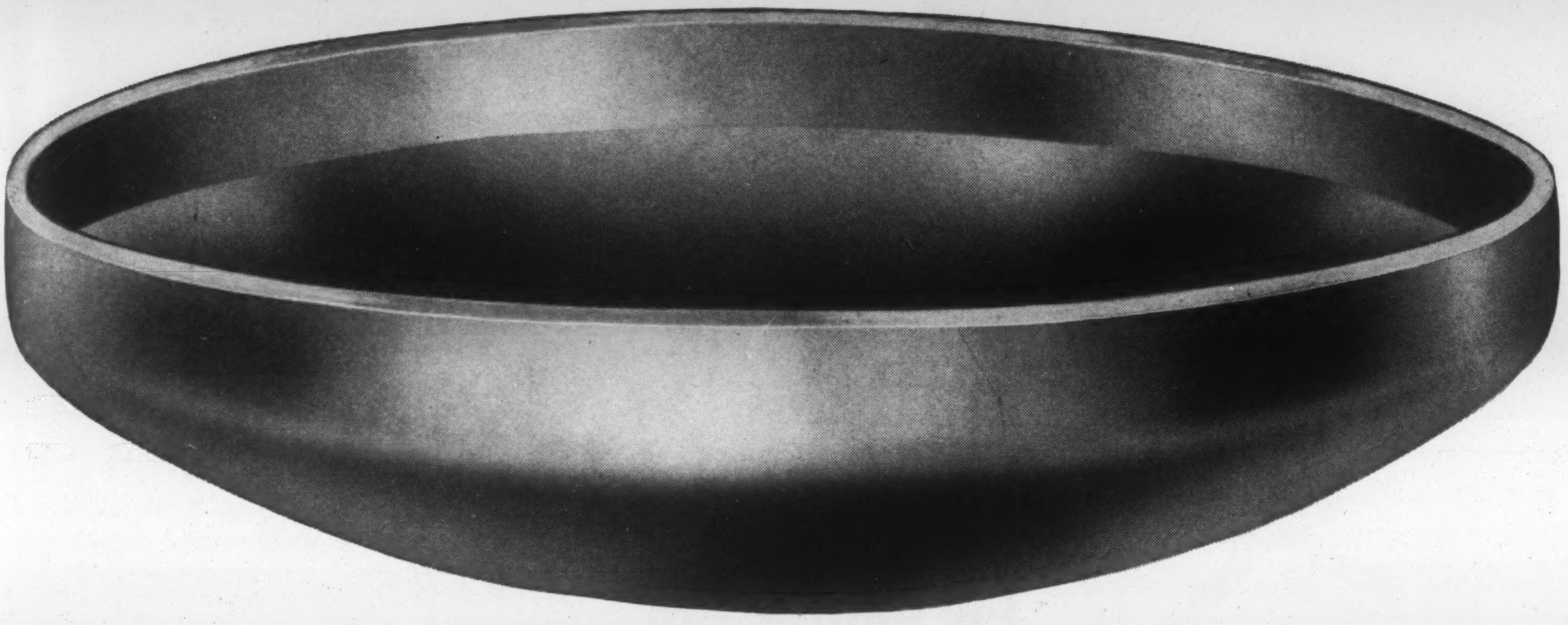

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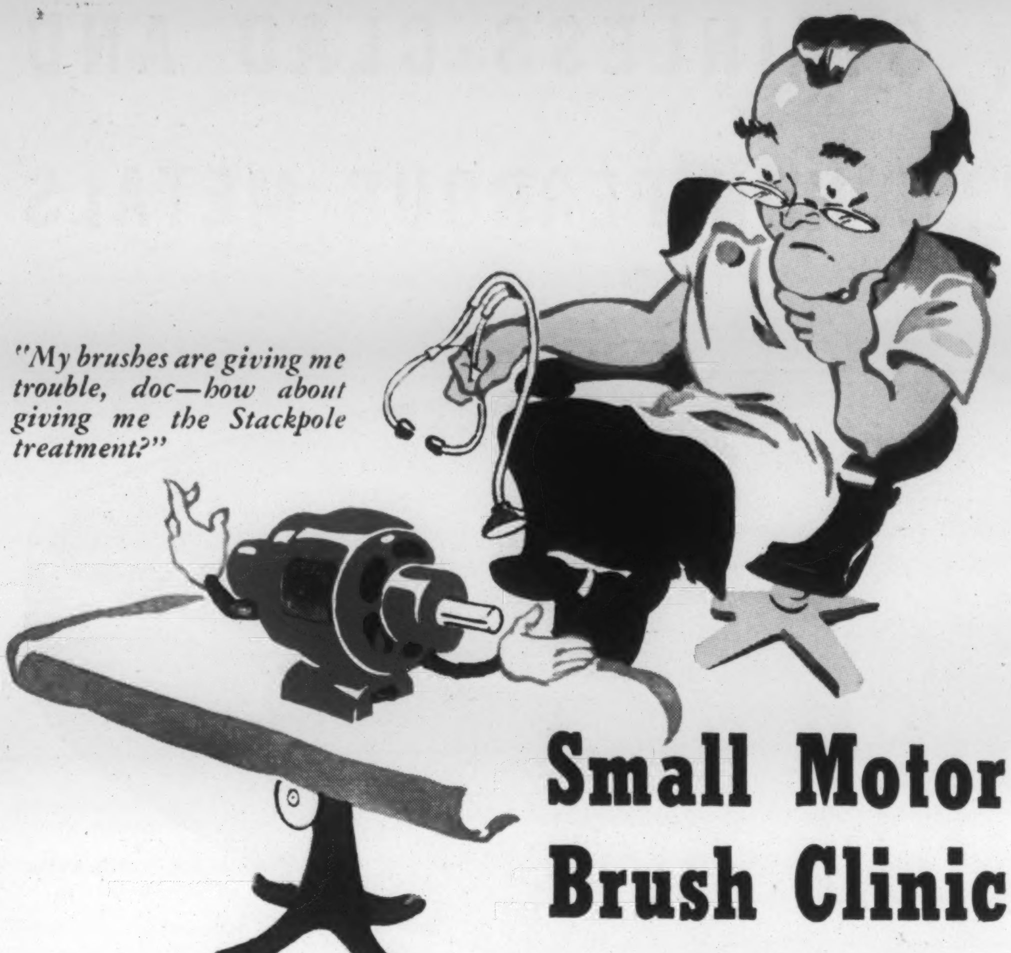
"My brushes are giving me trouble, doc—how about giving me the Stackpole treatment?"

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...for longer life, greater efficiency

No doubt, you're getting pretty good brush life and performance on small motor applications these days. *But, chances are still mighty good that they can be materially improved—at no premium cost.*

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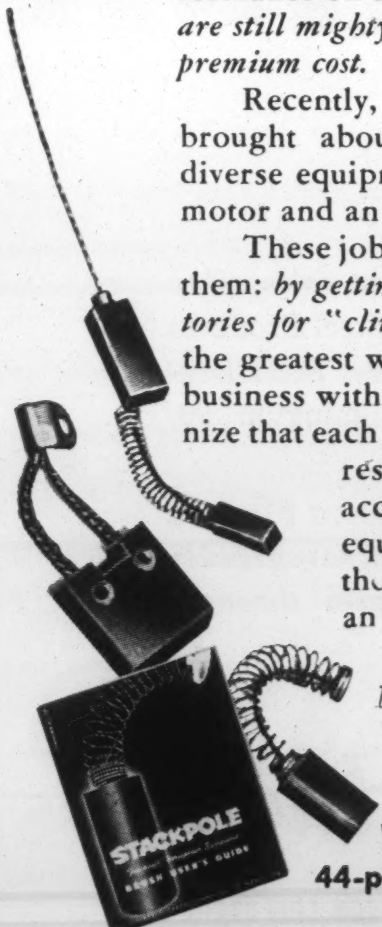

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Write on company stationery for the 44-page Stackpole BRUSH USERS' GUIDE.

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New Materials, Parts and Finishes

corrosion resistance are required. According to the manufacturer, it resists oxidation, does not readily heat-check under pressure at elevated temperatures and is unaffected by most common corrosive chemicals and atmospheres. As deposited, Walloy No. 6 welds have a hardness of 40-44 Rc, a tensile strength of 105,000 psi, specific gravity of 8.3 and melting point of 2325 F.

All-State HS-1 Hard-Surfacing electrode, developed by *All-State Welding Alloys Co., Inc.,* 249-55 Ferris Ave., White Plains, N. Y., is a chromium-manganese-nickel alloy and can be applied with either a.c. or d.c. equipment. It is particularly designed for abrasion and impact wear resistance on manganese steels and high carbon steels. It can be used as a base for hard-facing alloys or can be applied directly as a work-hardenable overlay. According to the company, deposits will work-harden to 48-50 Rc. As-welded, its tensile strength is 125,000 psi, elongation in 2 in. is 19% and hardness is 26-32 Rc.

Fluxes Aid Silver Brazing

A new series of fluxes designed to protect the base metal and promote the flow of silver brazing alloys up to 1750 F has been developed by *Eutectic Welding Alloys Corp.,* 40-40 172 St., Flushing, N. Y. The series consists of 5 Eutector T fluxes which are said to exhibit high wetting action, reduce surface tension and possess long flux life. According to the company, use of the fluxes will permit the use of low silver content alloys rather than the more expensive high silver grades.

Paste Solder for Sweating and Tinning

SweTite Paste Solder, a new solder paste for sweat soldering or tinning, has been developed by *Alpha Metals, Inc.,* 56 Water St., Jersey City 4, N. J. The paste consists of a 50-50 blend of powdered solder and active flux. For most applications, cleaning is unnecessary. The paste is brushed on, the parts fitted together and heat applied. Excess paste can be wiped off with a damp cloth after heating. According to the manufacturer, joints made in this manner are as strong as those produced by conventional soldering.

(More New Materials on page 156)

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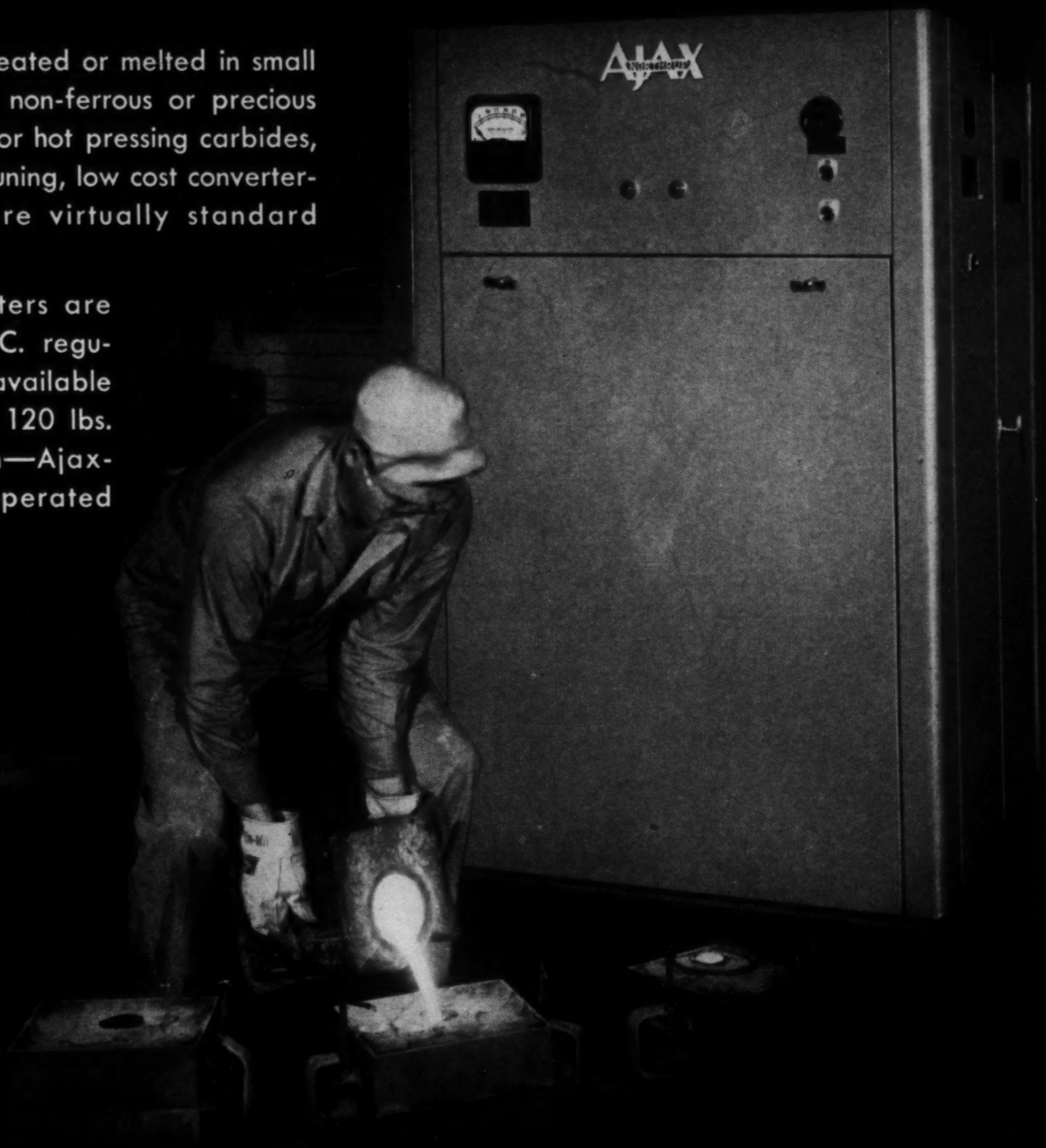

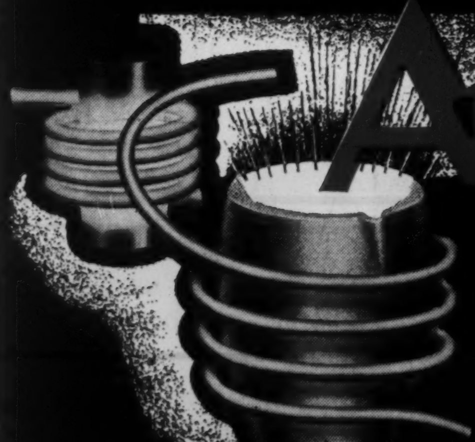

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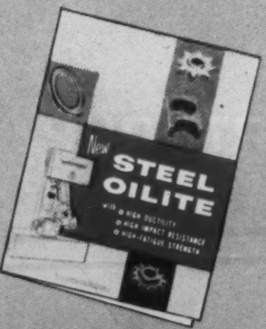


New Materials, Parts and Finishes

Contact-Type Adhesive Bonds Variety of Materials

A new adhesive which will bond metals, plastics, wood, rubber, leather and masonry surfaces with only contact pressure and a short oven cure has been developed by the *Midcontinent Adhesive Co.*, Grove City, Ohio. With the proper drying oven bonds can be cured in less than 3 min, according to the manufacturer. Called Roltite Industrial Cement, the adhesive is said to have good resistance to heat and sunlight. Specific materials recommended by the manufacturer for bonding with the material include plastic laminates, aluminum, steel, copper, plywood, wood veneer, Masonite, Novoply, rubber, leather and cement.

New Color-Free Polyester Plastic

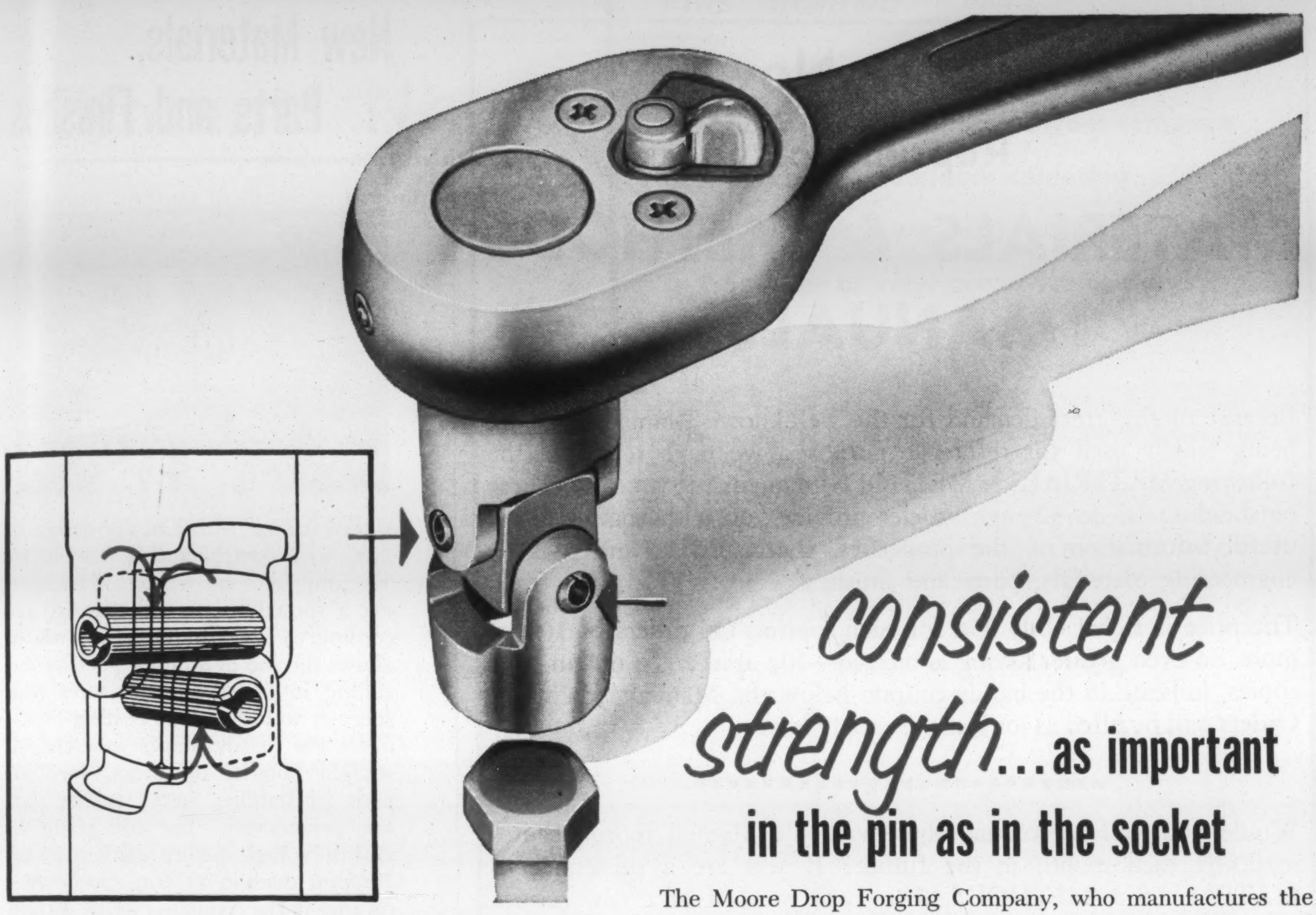
A new color-free polyester resin particularly designed for use in corrugated and other types of panels has been developed by the *Plastics Div., Celanese Corp. of America,* 180 Madison Ave., New York 16. Called Marco MR-28RC, the resin is said to have a color index 25% lower than the APHA industry standards and is available with no price premium. It can be light-stabilized with an additive, or can be supplied with stabilizer included. The company is also inaugurating a technical assistance program for fabricators using this type of resin.

New Automatic Welding Equipment Cuts Costs, Time

Higher welding speeds, better quality welds and lower operating costs are claimed for a new consumable-electrode, inert-gas arc welding process for welding mild steels in thicknesses of 1/16 in. and upwards. Developed by *Westinghouse Electric Corp.*, Buffalo, N.Y., the West-ing-arc process can be used either as a semi-automatic process, where an operator holds the gun, or as an automatic process where the gun is clamped and the work moved or the wire is fed through an automatic head.

West-ing-arc MS-20 wire is de-

◄ For more information, Circle No. 410



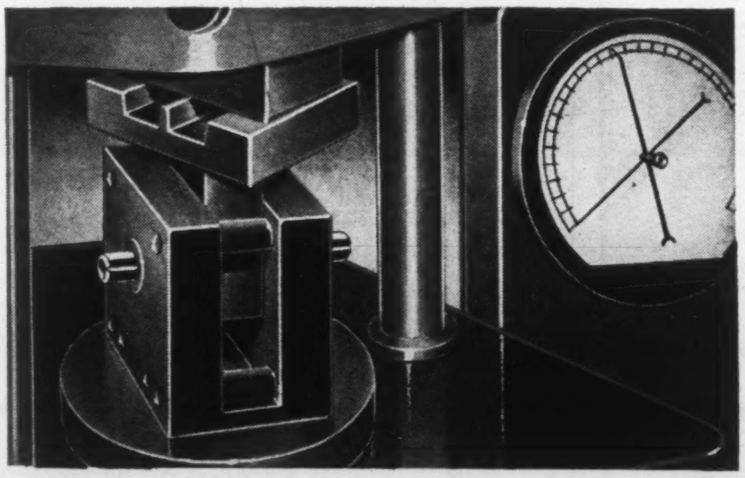
consistent strength... as important in the pin as in the socket

Normal leverage puts the load on the pins at these points. Pins must have a high resistance to shearing — and every pin must stand up to plenty of abuse. Many manufacturers' tests have proved Rollpin's uniformly high shear strength.

The Moore Drop Forging Company, who manufactures the famous Craftsman wrenches for Sears Roebuck and Co., used stainless steel rivets to fasten the universal joint on their Flex sockets. Thorough testing, under all possible load conditions and drive angles, convinced them that Rollpin was stronger than the stainless steel rivet previously used. This led to a redesign of the joint with Rollpins replacing the rivets. Also, the spring tension inherent in the Rollpin locking principle was used to provide the "drag" that holds the socket head in angular position. The result . . . an improved product at lower cost.

Dependability like this is based on the rigid ESNA® quality controls that insure consistent strength and mean reliable performance by every Rollpin.

Moore Drop Forging Company was able to save assembly time, too. Rollpin is simply driven into holes drilled to normal production tolerances. It compresses as driven, locking itself in place by exerting pressure on the hole walls. In this case, the extra operation of spinning on a rivet head was eliminated.



We urge you to test spring pins before you buy — for uniformity of diameter and length, hardness, insertion and removal forces, and recovery of diameter, as well as shear strength.

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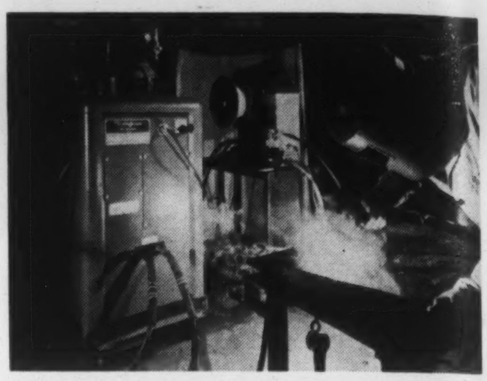
New Materials, Parts and Finishes



signed for use with a newly designed gun, wire control and a new RCP, 500 amp, d.c. arc welder. The wire has a specially designed coating, according to the manufacturers, which allows the use of straight polarity resulting in faster burn-off rates and speedier welding. The coating minimizes the disadvantages inherent in straight polarity operation, such as poor arc stability, heavy spatter and low penetration. The end result is said to be high quality welds at 15 to 20% increases in welding speed. According to the company, welds do not need cleaning before painting since there is virtually no spraying, spatter or slag cover on the weld. Primarily intended for horizontal and flat position welding, the new process is not yet developed for vertical or overhead welding.

The MS-20 wire is made of special analysis mild steel in diameters ranging from 0.040 to 0.091 in. Physical properties of the deposits at various temperatures are as follows: tensile strength, psi 76,000 at 80 F, increasing to 111,500 at —200 F; yield point, psi, 63,200 at 80 F, increasing to 109,200 at —200 F; elongation (% of 2 in.), 27.9 at 80 F, and 27.13 at —200 F; impact strength (V-Notch Charpy Impact Test), ft-lb, 100 at 80 F, and 22 at —100 F.

The electrode gun, rated at 500 amps, is light-weight and balanced for convenient use. The wire control feeds the electrode at a constant preselected speed under all loads, and current is automatically regulated by rate of wire feed. The constant potential power supply is rated 220/440-v, 60 cycle, 3 phase. Its continuous current rating is 500 amps at 34-v load, and it has a relatively flat volt-amp characteristic. Efficiency of the welder is said to be about 82% and the power factor is in excess of 95% at continuous rated load. Output may be varied from 15 to 40.5 v on a calibrated dial.

Contents Noted

A digest of papers, articles, reports and books of current interest to those in the materials field.

This Month:

- ***German high temperature materials***
- ***Fabrication of titanium powder compacts***
- ***A survey of aluminum soldering***
- ***High temperature creep of copper-nickel***
- ***Properties of vinyl protective coatings***

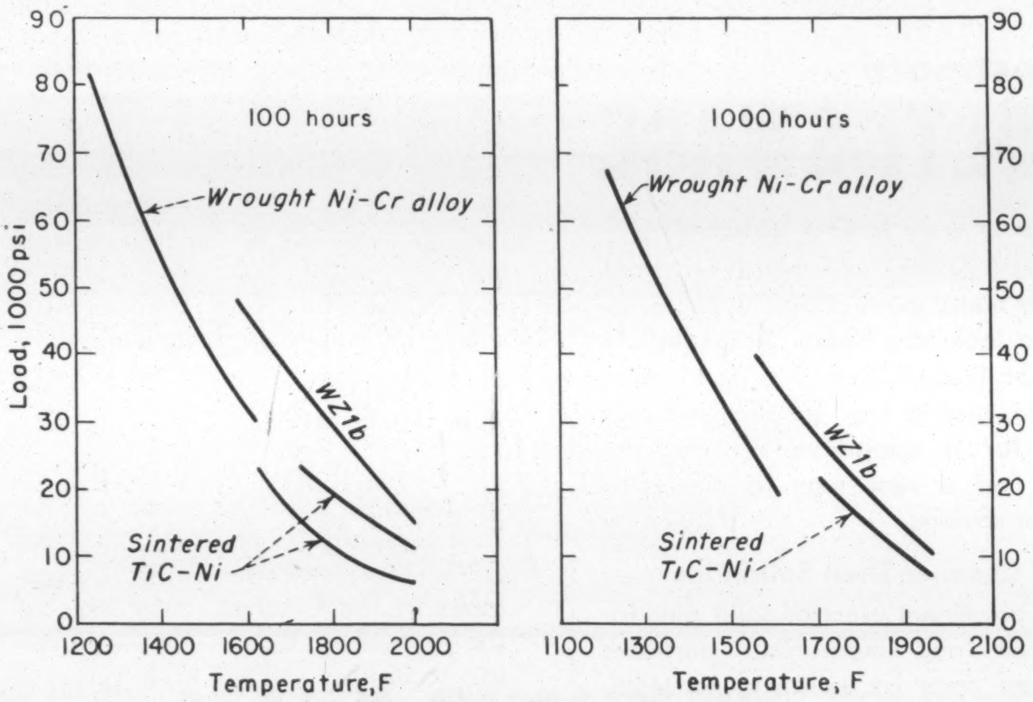
A German View of High Temperature Materials

The search for materials to withstand higher service temperatures is a continual one. The special steels and nonferrous alloys now used for gas turbine and rocket blades, nozzles and combustion chambers are not adequate for the significantly higher working temperatures desired for better performance. The high melting point metals such as tungsten, molybdenum, columbium and tantalum are limited because of their inadequate oxidation resistance. In an article in the August-September, 1954 issue of *Werkstoffe und Korrosion,* (German), F. Benesovsky concludes that it is probable that only powder metallurgy holds the key to high temperature materials of the future. He points out that already some of the hard sintered materials have proven themselves for this use: titanium-carbide base materials for gas turbine blades and wheels, borides for nozzles, and molybdenum-silicon alloys for heating elements.

Carbides, Borides, Silicides and Oxides

The WZ alloys (WZ having been derived from the German terms for "heat and scale resistant") consist of titanium carbide with a nickel-chromium, cobalt-chromium or nickel-cobalt-chromium bond. These grades have been available in considerable quantities for investigation. Turbine wheels of WZ alloys have operated experimentally at 20,000 to 30,000 rpm at temperatures of 1800 to 1900 F, so the assumption appears justified that they will withstand service temperatures up to around 2000 F. The oxidation resistance of these materials is superior to that of the tungsten carbide-cobalt alloys. On heating them in air a dense, adherent, protective coating forms which is largely impermeable to gases.

The author goes on to point out results of investigations in the U. S. with borides, silicides and oxides. Titanium and zirconium borides are hard, scale-resistant compounds with high melting points. Zirconium boride is said to be superior to all other materials for nozzles. Silicides have relatively high melting points combined with good corrosion and scale resistance. Less resistant materials may be coated with silicides, or silicide powders may be formed into finished parts by powder metallurgy. Experimentation has been carried out using sintered molybdenum-disilicide heating elements which are metallic in nature, have good strength and resist scaling in air up to around



Comparative Stress Rupture Strength

Properties of WZ Alloys*

Grade	Composition, %				Vickers Hardness Number	Rupture Strength, 1000 psi
	TiC	Ni	Co	Cr		
WZ 1b	60	32	—	8	1010	190–210
WZ 1c	50	40	—	10	830	210–240
WZ 2	60	—	28	12	1160	160–180
WZ 3	50 + 10 TaC	32	—	8	1070	200–210
WZ 12a	75	15	5	5	1220	149–165
WZ 12b	60	24	8	8	1090	185–205
WZ 12c	50	30	10	10	860	210–235
WZ 12d	35	39	13	13	720	240–255

* *Density 6.0–6.6 gm/cc.*

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Contents Noted

German materials . . .
Titanium compacts . . .

3000 F. Strength and electrical resistance can be increased by suitable binders.

Pure high melting point oxides such as alumina, zirconia and beryllia, as well as oxide mixtures and silicates also have good resistance and strength at high temperatures. Their practical value, however, is strongly impaired by brittleness and lack of resistance to temperature changes. Although these deficient properties may be improved by the addition of such metals as iron or chromium, such combinations have not been used to any significant extent despite their interesting high temperature properties.

Powder Metallurgy—One Answer to Titanium Fabrication

In addition to the conventional methods of fabricating titanium, the Brush Laboratories has developed two powder metallurgy methods which seem to meet the stringent requirements for handling the metal. Both hot pressing and press forming produce end products which are of uniform quality both chemically and metallurgically. Contamination by oxygen, nitrogen, carbon and hydrogen is kept at a minimum level no greater than that of the sponge from which the shapes are made. The powder is derived from a commercial grade of ductile titanium sponge.

Two Techniques

The two processes and the properties of the resultant parts are described briefly by H. W. Dodds and G. F. Davies of the Brush Laboratories in the October, 1954 issue of the *Journal of Metals*. The hot-pressing technique utilizes high vacuums and temperatures to prevent gaseous contamination and to remove volatile constituents such as magnesium and magnesium-chloride. Parts weighing as much as 125 lb and as large as 9 in. in diameter have been produced with present equipment. For intricate parts generally less than 4.5 lb of sponge are needed to make a 1-lb machined part. Surface contamination by the graphite dies is generally less than 0.005 in. deep. The method is particularly suited to prototype production of contoured cored shapes such as might be produced normally by casting.

The press-forming method is best suited to the production of large quantity, low cost parts. Parts are pressed from powder and sintered in a vacuum which tends to remove volatile constituents. The pieces are then subjected to subsequent forming operations to produce the finished shape. Usually 1.7 lb of sponge are required to make a 1 lb piece. Precision alloy steel dies are used and high density or controlled porosity may be obtained.

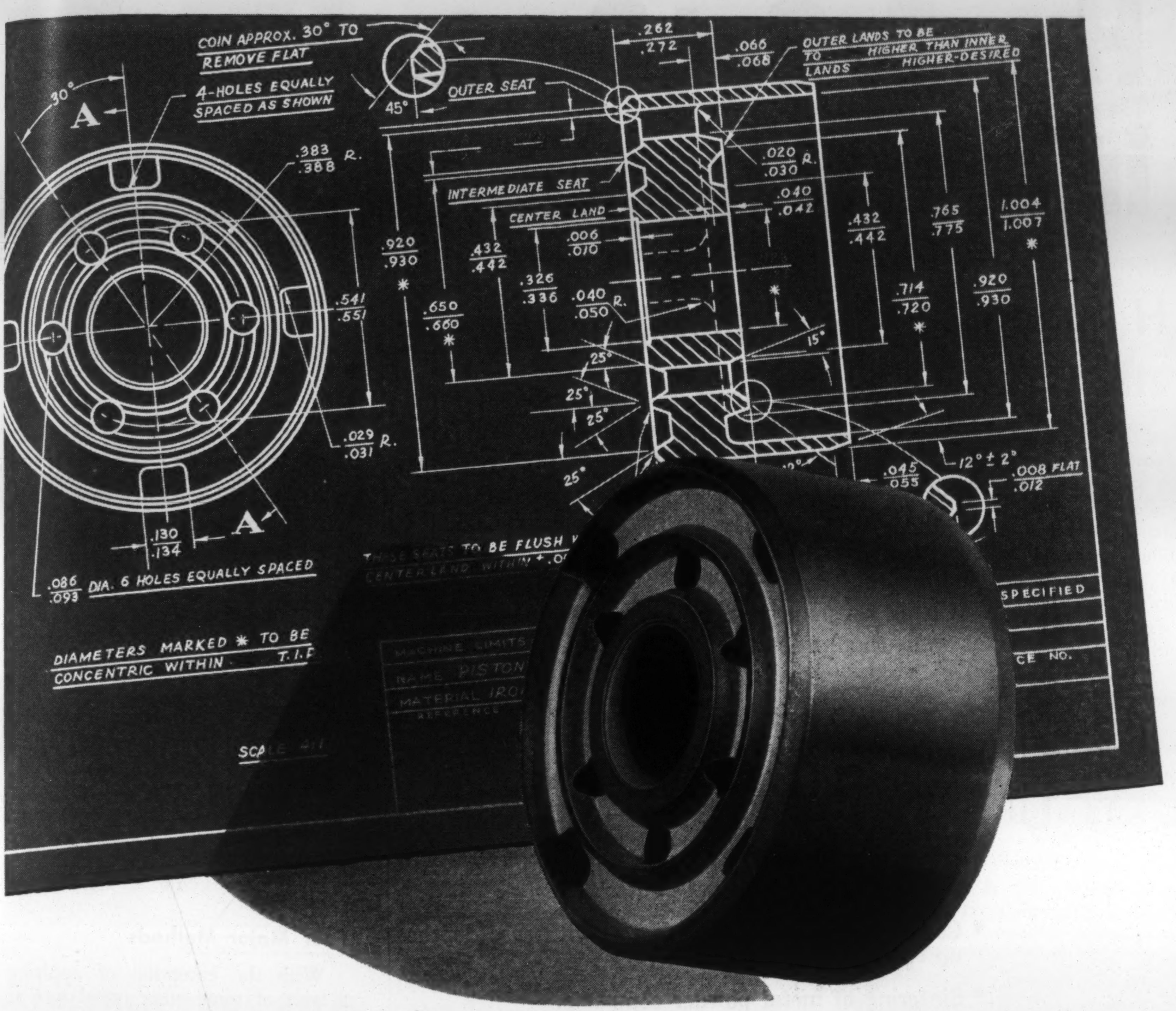
Mechanical Properties

The tensile properties of the specific alloy used (Ti-Brush 40) were determined with a 0.25-in. diameter tensile specimen having a 1-in. gage length. Typical room temperature mechanical properties are: Tensile strength, 59,000 psi; yield strength, 40,000 psi at 0.2% offset; elongation, 35%; reduction in area, 53%; hardness, 43-48 Rc A and a density of 4.5 gm per cu cm. Notched and unnotched fatigue tests indicate a fatigue strength of slightly over 30,000 psi at 10^7 cycles. Endurance ratios of 50 to 52.5% have been obtained consistently with parts fabricated by these techniques. This is in comparison with earlier reports on titanium powder metal products which indicated endurance ratios of 30 to 33%.

Charpy notch impact tests were carried out at various temperatures, and the impact energy was found to remain relatively constant, between 36 and 41 ft-lb over a wide range of temperatures. The authors conclude that the processing methods used to produce Ti-Brush 40 maintain hydrogen at a low level preventing subsequent embrittlement. And since other impurities are kept at a relatively low level, these effects on the notch impact strength are minimized.

The advantages of these processes appear obvious: reduced machining time, less raw material required, and low scrap loss. In billet form, the material appears comparable to arc melted stock for extrusion, drawing or forging. As a fabricated shape it possesses the high degree of uniformity characteristic of most powder metal parts.

(More Contents Noted on page 166)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TO HIGHER-DESIRED
.383
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INTERMEDIATE SEAT
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CENTER LAND
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THESE SEATS TO BE FLUSH
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SPECIFIED
DIAMETERS MARKED * TO BE CONCENTRIC WITHIN T.I.R.
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Contents Noted | Soldering aluminum . . .

A British Survey of Aluminum Soldering

Aluminum has been considered one of the difficult-to-solder metals. This is due to several factors, such as its high thermal conductivity and its high specific heat. The most important single factor, however, is the nature of the stable oxide film which forms on aluminum and which gives it its high corrosion resistance. As well as being chemically stable the oxide has a melting point in excess of 3500 F and is not easily removed by fluxes which operate at temperatures low enough for soft soldering. Today, however, by selecting the suitable technique, material and application, soldering can be an important addition to other methods of joining aluminum. In the August, 1954 issue of *Research* (British), J. C. Bailey and J. A. Hirschfield of the Aluminum Development Association discuss these factors in a survey of progress in the development of aluminum soldering.

Four Major Methods

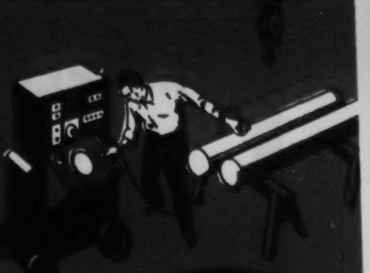
With the exception of applying a layer of some other metal such as copper or silver, there are four main methods for soldering aluminum. The first is friction or abrasion soldering. A pool of molten solder is deposited on the aluminum surface, and the oxide is scratched off under the solder, allowing the solder to tin the abraded surface. The molten solder excludes the atmosphere and an oxide film cannot form between the aluminum and solder.

The second method makes use of so-called reaction solders. These usually consist of heavy metal chlorides. When heated, they react, forming aluminum chloride which breaks up the oxide film and allows the heavy metal to tin and possibly alloy with the aluminum.

The third method, ultrasonic soldering, depends on cavitation erosion which disrupts the oxide film. Gas bubbles in the solder expand and contract with each ultrasonic vibration and build up forces which are sufficient to break up or erode the film.

The last, and most recently developed method involves the use of an active flux. The composition of

Tool Steel Topics



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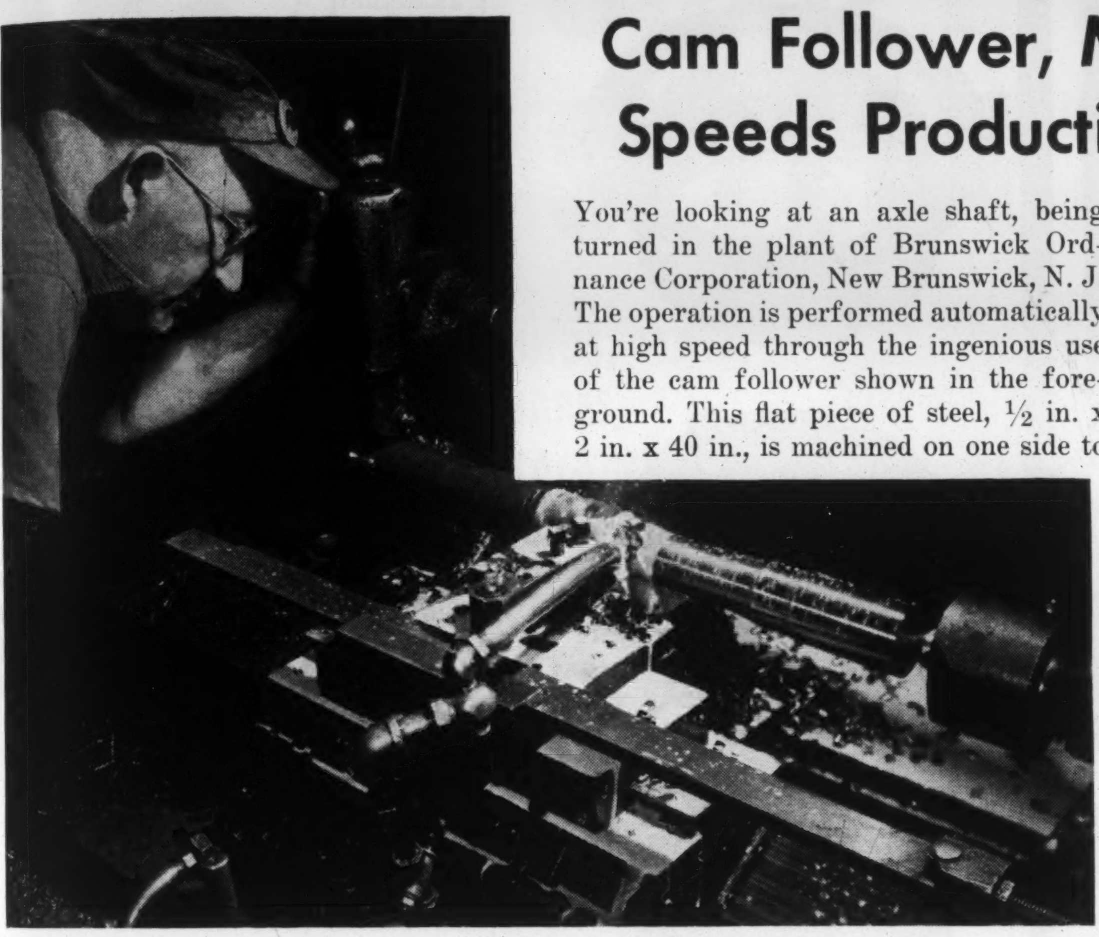

Cam Follower, Made of Lehigh H, Speeds Production of Axle Shafts

You're looking at an axle shaft, being turned in the plant of Brunswick Ordnance Corporation, New Brunswick, N. J. The operation is performed automatically at high speed through the ingenious use of the cam follower shown in the foreground. This flat piece of steel, ½ in. x 2 in. x 40 in., is machined on one side to the contour of the finished shaft. It moves parallel to the rough bar, making contact with a wheel, beneath the coolant pipe, which in turn actuates the carbide bit.

Engineers at the Brunswick plant needed a steel with good machinability for the cam follower. But above all, they wanted maximum resistance to wear. Which steel did they choose? Lehigh H, our special-purpose high-carbon, high-chromium tool steel.

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Tool Failures Can Be Caused by Magnetism

Magnetism of either stock or tools can cause mystifying failures of tools. This is particularly true of punch-and-die sets, blanking tools, and occasionally, forming tools. Difficulties traced to magnetism can develop in these ways:

1. Improper feeding or positioning of stock.
2. Improper ejection of parts or scrap.
3. Several multiples feeding in at one time on some operations.

Overloading of tools produced by any of these three conditions can cause tool failure. Besides, magnetized parts pick up steel "debris," which acts as an abrasive on cutting edges, resulting in rapid tool wear. Steel stock can be magnetized by lifting with magnets, or by passing near electrical machinery or power lines carrying heavy currents. Tools are often magnetized by being ground on equipment using magnetic chucks. They can also be magnetized by other accidental means.

When steel parts or tools show evidence of magnetic attraction to each other, or when the edges attract steel chips or debris, steps should be taken to eliminate the magnetism. With steel stock, this can be done by tempering. But tools must be demagnetized with a demagnetizing coil, by passing them slowly in and out of the coil while it carries alternating current.

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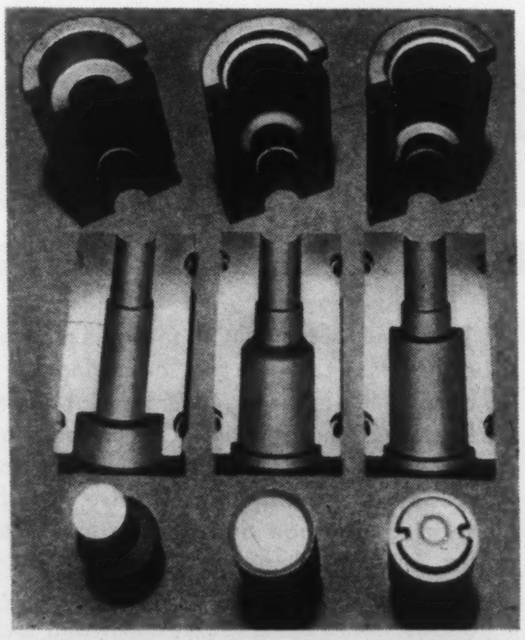
With BTR Hollow-Bar, there's no need to wait for forged rings or discs. Nor is there any drilling, rough boring, rough facing or rough turning required. You can get full particulars about BTR Hollow-Bar from your tool steel distributor.



Chrome-Moly-Tungsten Lengthens Die Life

Shown here are sets of forging insert dies and (at bottom), upset punches, used in a hot-work application. The heat-treatment consists of air-quenching and double-tempering to Rockwell C 35-41 for the inserts, and Rockwell C 45-49 for the punches. Said the user, "We like the minimum size change when heat-treating CMW. We get less heat-checking on die impressions, and better resistance to washing effect. And they add up to long die life, which is just what we want."

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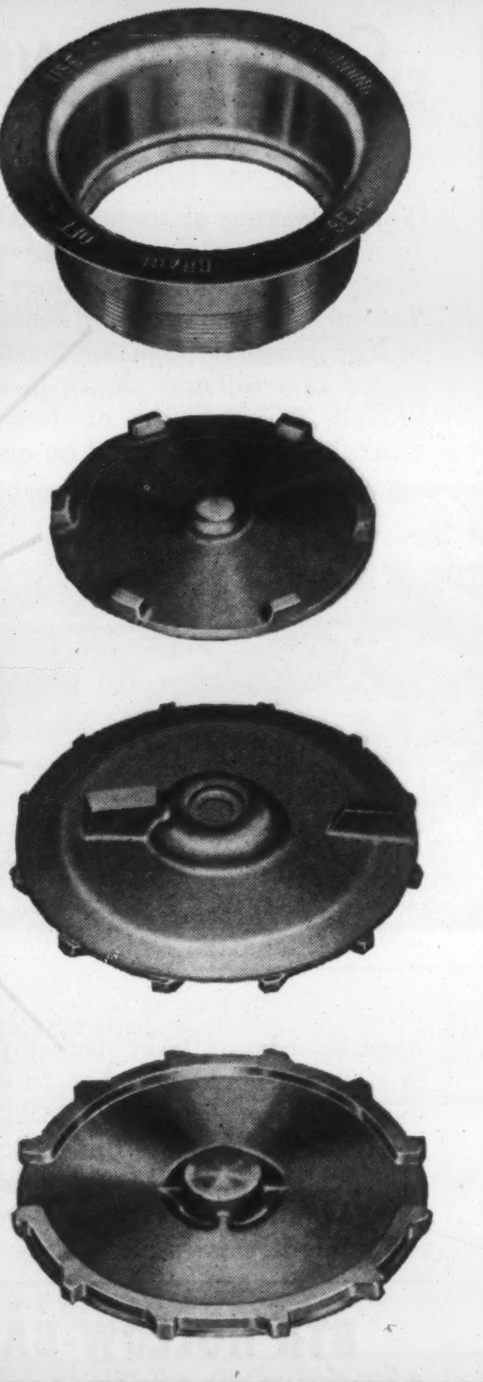
*MUELLER BRASS CO. facilities include: designing, die-making, forging, tooling, machining, polishing, plating and assembly



Three Mueller Brass Co. forgings play an important part in the fine operating performance of this modern waste disposal unit made by the Eureka-Williams Co., Division of the Henney Motor Co., Inc. This unit does a speedy and thoroughly effective job of pulverizing garbage and has made life easier for American housewives. The impeller disposer that chops up the waste food in the disposal unit, the disposer cover and the sink mounting flange are all forged by the Mueller Brass Co. This is another outstanding instance where Mueller Brass Co. forgings have improved product performance and cut costs. High quality forgings can be produced from standard and special brass, bronze and aluminum alloys. And in addition, the Mueller Brass Co. offers complete service ranging from product design to finished part . . . Write today for complete information and new 32 page forgings handbook.

1. Sink mounting flange, forged, machined, nickel and chrome plated by Mueller Brass Co.
2. Machined and finished disposer cover forging.
3. Cutting side of impeller disposer forged from 600 series bearing bronze.
4. Reverse side of impeller disposer.

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◄For more information, Circle No. 360

Contents Noted

Soldering aluminum . . .

the flux is such that upon heating in contact with aluminum an active reagent is liberated which attacks the oxide film, and a layer of the metal is deposited which diffuses into the aluminum.

Solder Compositions

Solders for aluminum can be broadly classified under three headings: zinc-base, tin-base, and those of a more complex and highly alloyed nature. In the binary alloys of tin and zinc, suggested compositions range from 90 to 30% tin and from 70 to 10% zinc. Another binary system, the zinc-cadmium series has been proposed, but according to the authors these have not aroused much interest until very recently. The ternary system tin-zinc-cadmium provides the basis for many suggested aluminum solders. This system forms a ternary eutectic melting at 320 F with a composition of 73 tin, 24.9 cadmium, and 34% zinc and includes solders of widely varying properties.

Many alloy additions have been made to the various solders. No precise conclusions can be reached; however, the general effect of the addition of each material can be summarized as follows:

Aluminum—increases strength of joint; however, seems to embrittle tin-lead solders.

Copper—increases strength and hardness, lowers corrosion resistance.

Manganese, bismuth and antimony—increases hardness.

Phosphorus—acts as a de-oxidant for tin and improves fluidity, but may retain phosphorus or phosphates which would lower strength.

Iron—reduces fluidity and corrosion resistance.

Silver—increases corrosion resistance.

Cerium—with tin-rich tin-zinc solders, increases corrosion resistance and fluidity.

Cadmium—gives high corrosion resistance to zinc-base solders.

Characteristics of Joints

The average strengths of soldered aluminum joints range from 2.5 to 5 tsi, normally calculated for the overlap of lap joints. The strength of a joint is affected by the composition of the solder and parent metal, the thickness of the solder layer, the susceptibility of the joint to corrosion

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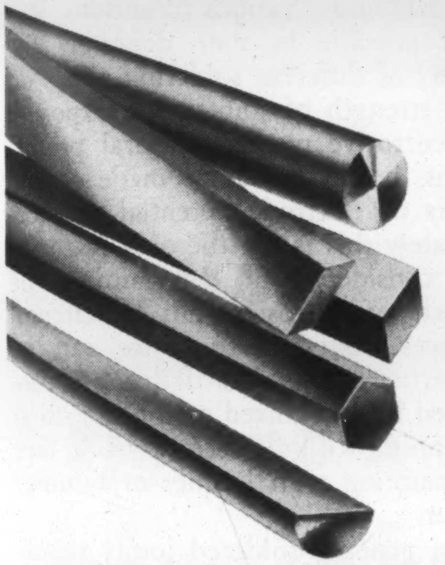

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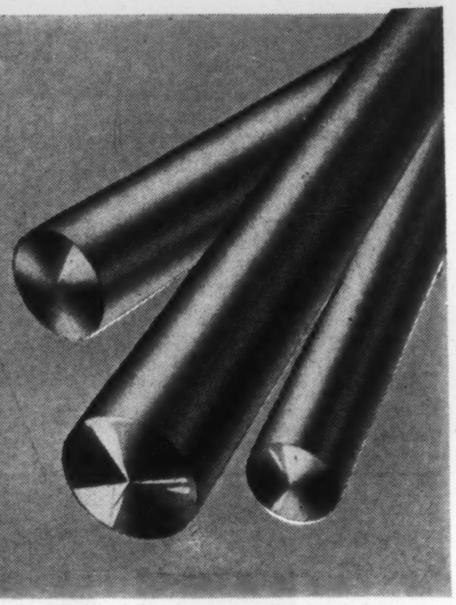

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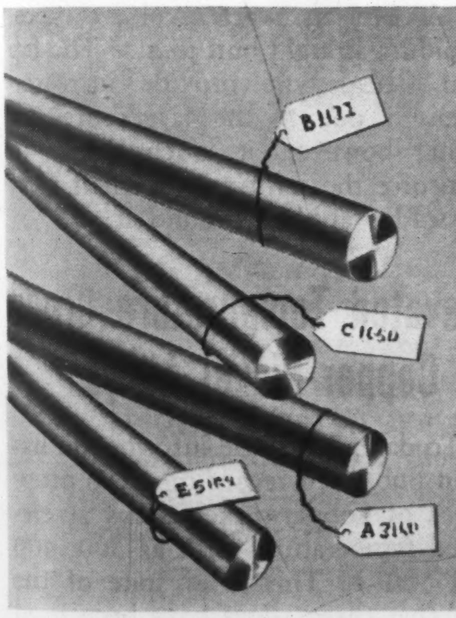

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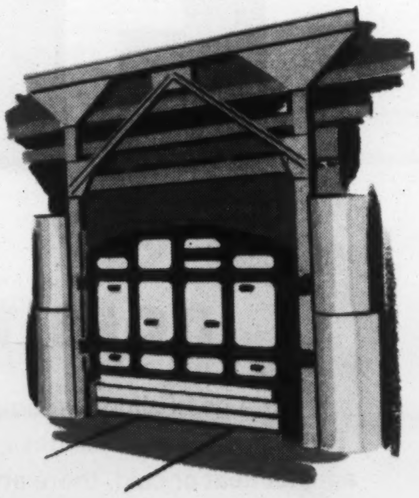

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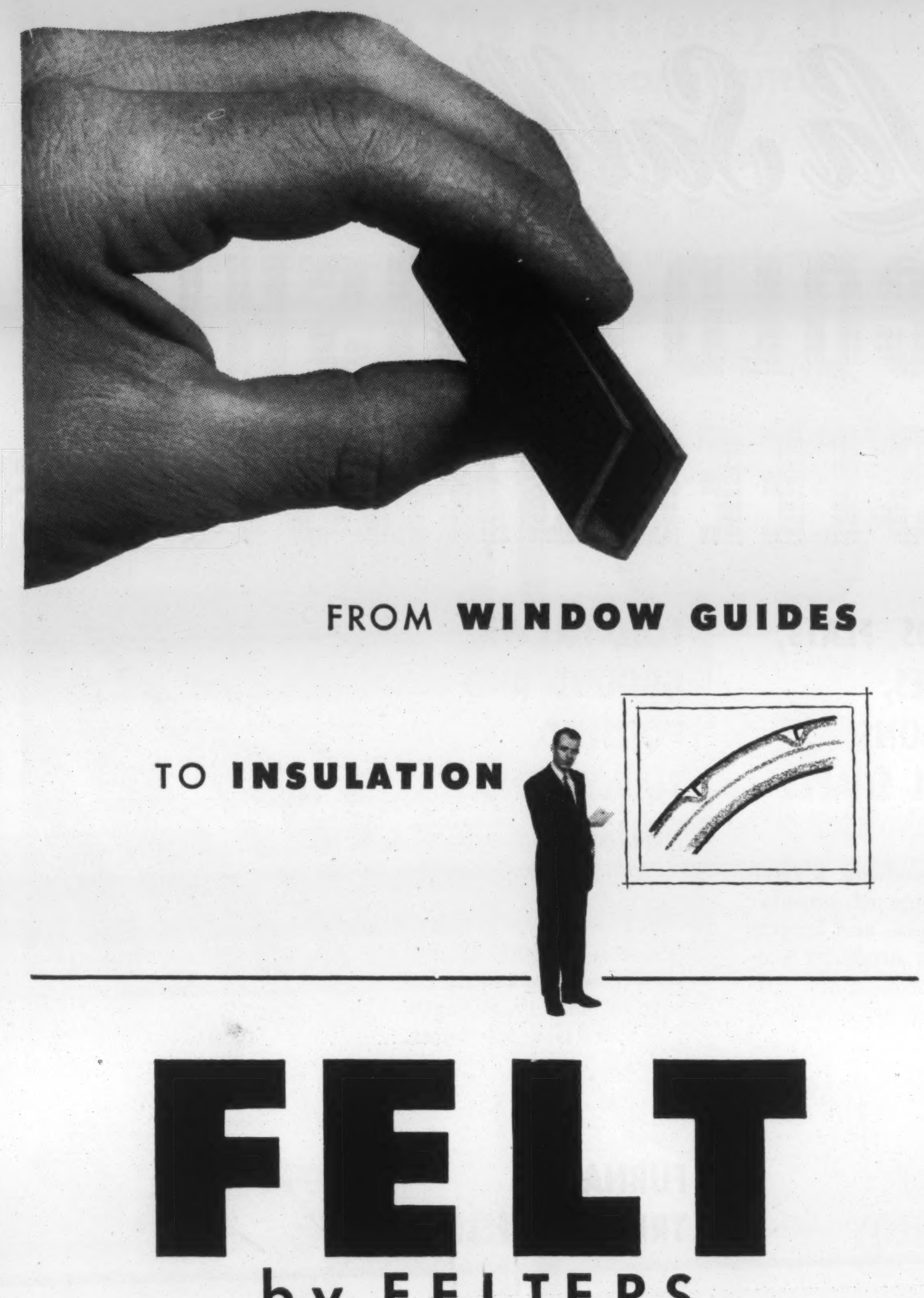
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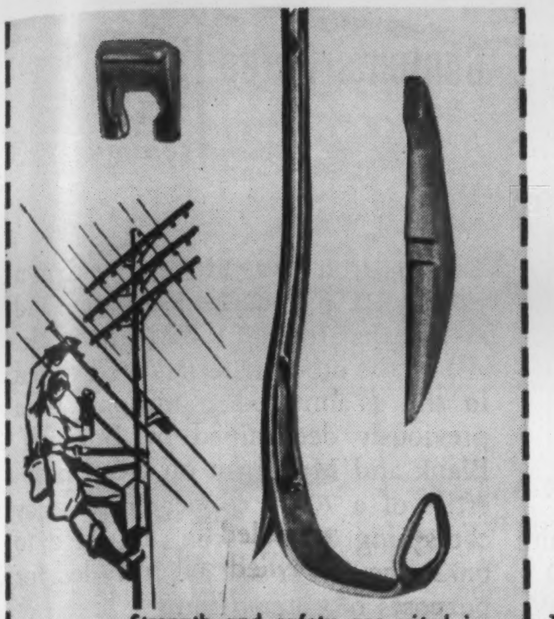
and the design. Since the thinner the layer of solder, the stronger the joint will be, joints should be made with as little solder as possible compatible with complete joint filling.

Corrosive attack on a joint may well stem from galvanic corrosion arising from a difference in solution potential between the parent metal and the solder alloy. Zinc-rich solders generally give better corrosion resistance and suffer less loss of strength under corrosive conditions than other compositions. Despite a mass of information on specific solders under various conditions, it is not possible to state definitely the effect of different soldering alloys on the strength of joints after exposure in corrosive media. General predictions, however, can be made on the basis of electrode potential. Unfortunately this is not the only factor to be considered in determining the effects of corrosion. In all circumstances better performance can be expected from joints if they are protected by recognized methods such as wrapping with moisture-resisting tape or painting with lacquer or bitumen paint.

In general, soldered joints should be of the lap, scarf or sleeve types, avoiding straight butt joints. The lap and sleeve type provide increased strength due to the larger area of joint; however, it is customary to reinforce the joint with a small fillet of solder applied around it.

Elevated Temperature Creep of Copper-Nickel Alloys

To date, very little information has been published regarding creep properties of copper-nickel alloys at elevated temperatures such as 300, 400 and 500 F. This is in spite of the fact that these alloys have been used for many years at these temperatures in applications involving stress. In a paper presented at the Annual Meeting of the American Society for Testing Materials in June of this year, J. H. Port and A. I. Blank of the Chase Brass and Copper Co. discussed the results of creep tests carried out at 300, 400 and 500 F on three copper-nickel alloys. The alloys tested were 90-10 copper-nickel containing 0.68% iron, 90-10 copper-nickel containing 1.08% iron, and 80-20 copper-nickel containing 0.19% iron. The 90-10 copper-nickel containing



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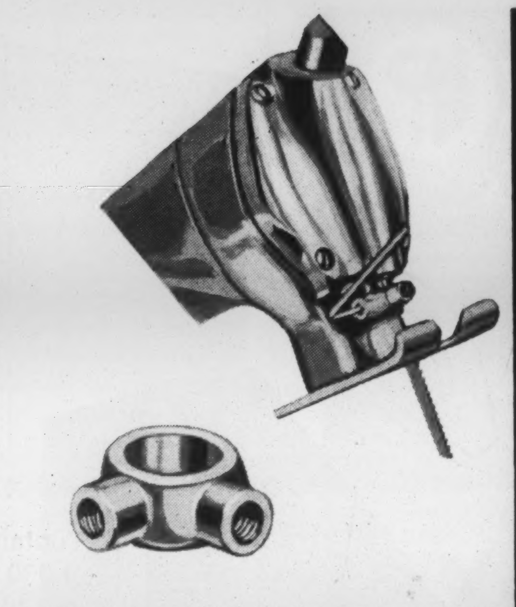
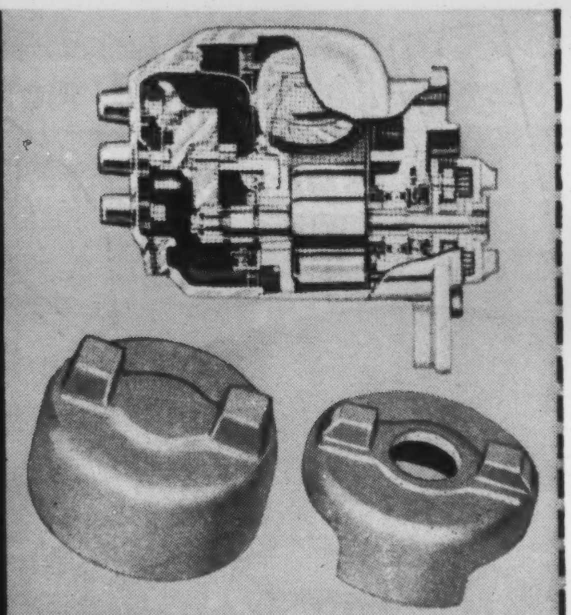


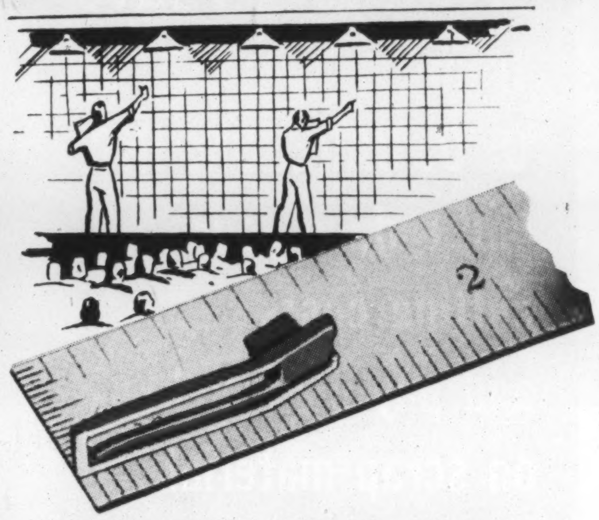
The exact size of this forged blade clamp on this versatile hand tool is 7/8" over-all width. Small forgings can be produced to exceptionally close tolerances—which means economical production with the highest obtainable degree of toughness and strength.



Forged drive cup for magneto impulse starter—forging this part in closed dies controls flow lines in the metal. Maximum resistance to strain exactly where it is needed is typical of why forgings stand up under shock or torsional stresses.

SMALL FORGINGS THAT DO A big job

Engine cowl and mounting bracket are typical of how lighter and thin sectional parts maintain the strength-to-weight ratio by forging.



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1.08% iron was tested as-drawn with a 21% reduction in area and as-annealed to 0.025 mm grain size. All of the other materials were tested in the as-annealed condition. Data previously determined by Burghoff, Blank and Maddigan on creep properties of a 70-30 copper-nickel alloy containing 0.03% iron, annealed to 0.020 mm grain size are included for purposes of comparison.

Comparison of Creep Properties

At all three test temperatures the creep strength of the annealed 90-10 copper-nickel alloy containing 1.08% iron was two or more times that of the 90-10 copper-nickel alloy containing only 0.68% iron. Free iron was observed in the former while none was detected in the latter.

In the annealed condition at 300 F test temperature, no significant difference was found between creep strengths of the 90-10 copper-nickel alloy containing 1.08% iron, the 80-20 copper-nickel alloy and the 70-30 copper-nickel alloy. At 500 F the creep strengths of the 80-20 and the 70-30 copper-nickel alloys were similar, but both were considerably higher than that of the annealed 90-10 copper-nickel alloy containing 1.08% iron.

The creep strength of the 90-10 copper-nickel alloy containing 1.08% iron was considerably improved by cold drawing to a 21% reduction in area. At 300 F the creep strength of this cold-worked material was greater than that of all the annealed materials. At 500 F it was about the same as that of the annealed 70-30 and 80-20 copper-nickel alloys. For creep rates produced by stresses above the proportional limits of these materials the total extension of the hard-drawn 90-10 copper-nickel is much less than that of the annealed materials because the initial extension is significantly less for the drawn material.

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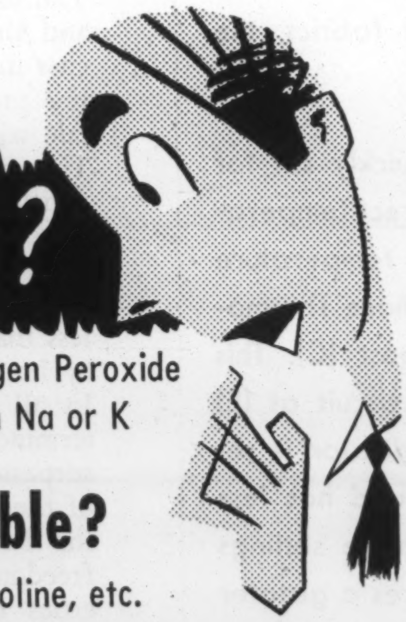

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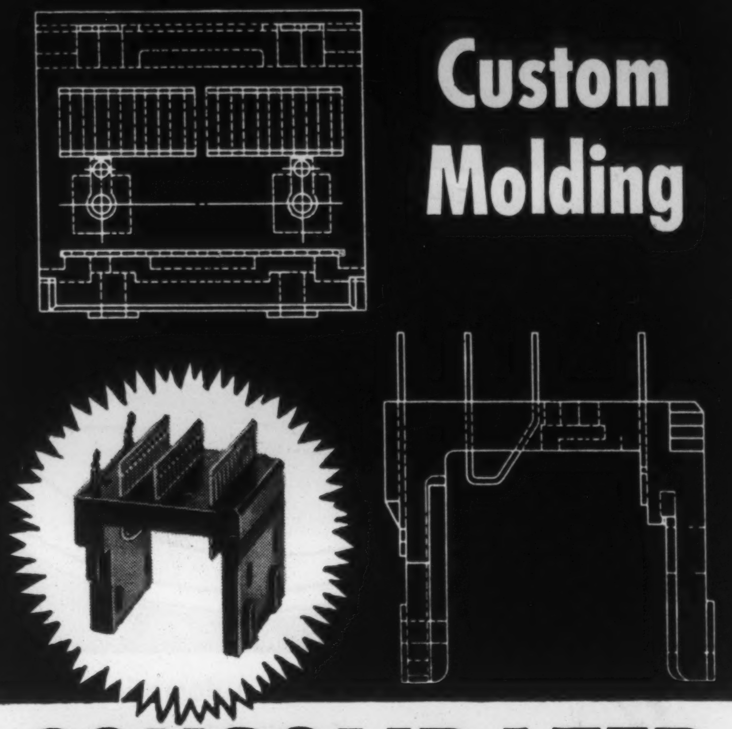

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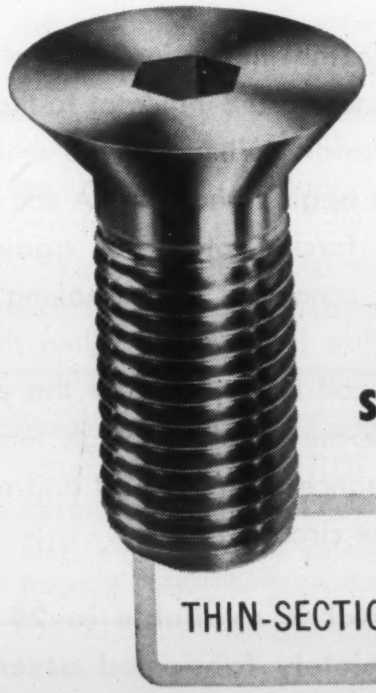

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HOW CHACE THERMOSTATIC BIMETAL CONTROLS THE Ironrite automatic ironer

WOOL
COTTON
LINEN
SILK
NYLON
RAYON
HI
A
B
C
D
E

Product of Ironrite, Inc.
Mt. Clemens, Mich.

Ironrite Automatic Ironers are designed from a functional as well as an aesthetic viewpoint, their chief advantage being speedy, efficient ironing of all materials in almost any shape or form. Simplicity of operation and control are some of the Ironrite Automatic Ironer's foremost features. Of course, for safe, foolproof regulation of temperatures for ironing different fabrics, the Ironrite depends upon Chace Thermostatic Bimetal.

The control switch shown in the illustration is simply, quickly set for temperature variations by moving the indicator to the correct temperature shown for various materials. Whenever the ambient temperature attains the maximum, things begin to happen. A coil of Chace Thermostatic Bimetal (A) rotates, forcing plate (B) against post (C). This leverage bends the circuit connector (D), breaking the circuit at (E) until the ambient temperature is lowered. When the indicator is set for low temperatures, the coil is adjacent to the post and has less distance to move to break the circuit. At high temperature settings the coil is at its extreme distance from the post and requires a greater amount of heat to break the circuit.

Chace Thermostatic Bimetal is available in 29 different types, in strip, rolls or in completely fabricated assemblies made to your specifications. Before development of your new controlling, indicating or protecting device, read our booklet "Successful Applications of Chace Thermostatic Bimetal." Write for your free copy of this valuable engineering data today.

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service Card, Circle No. 414

Contents Noted

Talc ceramics . . .

ceramics machined from block talc for insulators in the electrical industry has decreased with the development of better ceramic materials. However, there are still certain applications for which block talc insulators are considered indispensable. The material can be easily machined with ordinary steel tools and it has enough strength to withstand rough handling during machining. After machining it can be fired into a hard, strong material with a minimum of dimensional change. Since large blocks of natural talc—free from imperfections—are scarce, investigators have turned to the plentiful powdered talc in order to develop a worthwhile substitute material. It was found that phosphate-bonded talc formed by either dry pressing, hydrostatic pressing or hot pressing provided a material with mechanical and electrical properties equal to or better than those of the natural block talc.

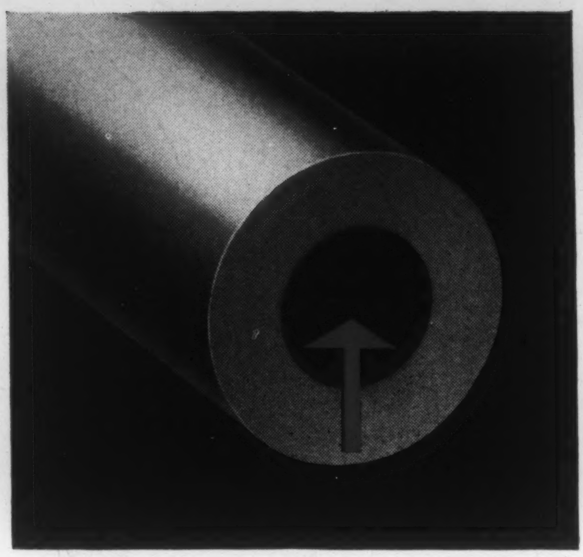
Comparative Properties

In a report in the April *Journal of The American Ceramic Society*, J. W. Comeforo, J. G. Breedlove and Hans Thurnauer of the Bureau of Mines and the American Lava Corp., discuss their investigations and compare the properties of phosphate-bonded talc with those of natural block talc. The authors found that though the density of natural Yellowstone block talc in both the unfired and fired state is greater than that of the phosphate-bonded talc, it is only slightly less than that of the material formed by hot pressing the bonded powder. In all other physical properties determined, the bonded talc equals or surpasses the natural block talc. One of the most significant advantages of the bonded talc is its comparative freedom from wide variation in properties from sample to sample. Although the lowest water absorption values for natural block are below the minimum measured for hot-pressed bonded talc, the authors feel that equipment limitations prevented their gaining the optimum results in this area.

The dielectric properties of phosphate-bonded talc were found to be superior to those of natural block talc both at room and elevated temperatures such as 660 F. Of the parts formed by the various forming methods, the hot-pressed shapes seemed to have the lowest power factor.

Once consolidated, phosphate-

a hole here is annoying . . .



a hole here is helpful

Crucible Hollow Tool Steel Bars are helping eliminate the wasteful practice of drilling out a solid bar to make ring-shaped, or tubular steel parts, or tools with a center hole. The hole is already in Crucible hollow tool steel bars . . . no need for drilling, boring, cutting-off or rough-facing operations.

You can get these hollow bars in any of Crucible's famous tool steel grades, in almost any combination of O.D. and I.D. sizes. And you can get *immediate* delivery of five popular grades—KETOS® oil-hardening, SANDERSON® water-hardening, AIRDI 150® high carbon-high chromium, AIRKOOL® air-hardening, and NU DIE V® work tool steels—from a conveniently located Crucible branch warehouse.

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Production is speeded up, too. Before this part was Microcast, plant schedules were constantly being thrown off due to crooked and porous castings. Since the Microcast valve comes ready for use (only a light grind on the periphery of the flute is necessary) this production headache has been eliminated. Find out today how MICROCAST can reduce your costs on small parts and components.

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bonded talc can be readily machined to close tolerances by standard machining techniques. The linear shrinkage is usually less than that measured on block talc. The absence of veins and irregularly distributed mineral impurities in the bonded-talc results in more uniform properties and a correspondingly lower number of rejects. It was also found that these properties are relatively insensitive to normal production variables, such as particle size, forming pressure and firing conditions. Of the phosphates investigated, orthophosphoric acid was found to be the most satisfactory bonding agent. The addition of the acid does not materially alter the firing range, though aluminum dihydrogen phosphate and magnesium dihydrogen phosphate have a mild fluxing action on the talc.

Polyvinyl Chlor-Acetates for Corrosion Protection

Vinyl-base organic coatings are widely used today for protection against chemical corrosion. Current definition includes among "vinyls" those polymers of vinyl chloride and copolymers of vinyl chloride with vinyl acetate, vinylidene chloride and other monomers in which vinyl chloride is the major component of the copolymer. Such copolymers are usually referred to as polyvinyl chlor-acetates. In order to clarify misconceptions and to provide factual, quantitative information as to their protective value, the Unit Committee T-6A on Organic Coatings and Linings for Resistance to Chemical Corrosion, of the National Association of Corrosion Engineers, has published a report dealing with application, and physical and chemical characteristics of vinyl-base coatings. This report is published in the October issue of *Corrosion* and appears here in digest form.

Two Rules for Design

There are many specifications for the proper design of equipment which will aid in insuring maximum protection by organic barriers. Underlying them all are two basic rules to be followed which will insure maximum service life of the equipment. They are:

1. *Avoid or eliminate all sharp edges or projections*—The surface tension of liquid-applied coatings

New Taylor laminates are premium in everything but price

YOU'LL LIKE everything about this new family of Taylor paper-base laminates—including their price. They're a new kind of hot-punch laminate, uniform all the way through, with no surface overlay of resin.

In insulation resistance, water absorption, power factor, flame retardance and dimensional stability, they'll meet or exceed your strictest specifications. And they punch and stake so well . . . with smooth surfaces and clean edges . . . that you can produce complex parts with maximum utilization of each sheet.

Four different grades are available in production quantities, in standard sheet size of approximately 49″ by 49″:

XXXP-301 . . . *the top grade laminate* with unusually high insulation resistance, lowest water absorption . . . excellent punching and staking.

XXP-351 . . . a high grade laminate with most of the properties of XXXP-301, at lower price.

Grade 353 . . . a quality grade laminate priced for economy, with outstanding electrical and physical properties.

Grade 354 . . . an easily fabricated grade having low water absorption and good stability . . . priced for real savings.

Taylor Fibre Co. Plants in Norristown, Pa.; and La Verne, Calif. *Branch offices in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

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VIX-SYN Synthetic Rubber PACKINGS
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will pull them from the apexes leaving insufficient coating thicknesses. All edges should be ground to a minimum radius of ⅛ in. and all projections should be ground flush.

2. *Avoid or eliminate all acute angles, crevices or pits*—The coatings will tend to accumulate in excessive thicknesses in such areas, resulting in slow solvent release and shrinkage stresses or cracks in the dried film. All inside corners should be fillet welded to a ⅛-in. minimum radius and all crevices or pits filled and ground smooth.

Resistance to Corrosive Media

Water and Moisture—The water absorption of typical vinyl corrosion barriers is between 0.1 and 0.15% during 24-hr exposure at room temperature. Their moisture vapor transmission rate approximates 10 gm/100 sq in./24 hr/1 mil thickness at 95 F and 100% relative humidity. Vinyls have a record of long successful use in marine applications and for locks and dams on inland waterways in submerged, splash zone and atmospheric exposures.

Inorganic Acids—Vinyls are resistant to all common inorganic acids. For continuous immersion in acids for which the corrosion rate of the base metal would normally exceed 0.05 in./yr, coating thicknesses should usually be at least 1/16 in.

Oxidizing Conditions—While the vinyls have greater resistance to oxidation than many organic materials, continuous exposure to concentrated oxidizing acids such as nitric, sulfuric, or chromic should be preceded by reliable trials to verify their suitability.

Organic Acids—Vinyls are not suitable for use with the lower aliphatic acids such as formic or acetic unless concentrations are less than 2%. Resistance to other organic acids, including fatty acids, is generally good but should be verified by service trials.

Alkalis—Vinyl barriers are inert to all common alkalis. Under ammoniacal conditions they should be used only after thorough test.

Salt Solutions—Vinyls are unaffected by most salt solutions. Wherever they are to provide protection against corrosive oxidizing salts such as ferric, cupric and mercuric salts whose normal corrosion rate would exceed 0.05 in. per yr, minimum thicknesses of 3/32 in. are recommended.

Solvents—Vinyls are softened or dissolved by ketones, esters, ethers and chlorinated and aromatic hydrocarbons. They are inert to alcohols and aliphatic hydrocarbons.

Oils—Vinyls are resistant to all common oils whether mineral, animal or vegetable in origin.

Properties of Applied Coatings

Temperature Limitations—Experience has indicated 150 F as the maximum safe temperature limit for continuous exposure. Under exceptional conditions satisfactory performances have been obtained at 230 F, but use at continuous temperatures in excess of 150 F should first be checked under service conditions. Vinyl films will generally provide dependable barriers down to -20 F, though decreasing temperatures gradually increase the hardness and brittleness of the material.

Impact and Abrasion Resistance—Vinyl films and linings are tough, flexible, distensible sheetings with good resistance to impact. Impact damage occurs mainly by a breakthrough or loss of adhesion to the base metal. It should be remembered that heavier coats can absorb impact shocks better than thinner coats.

Abrasion resistance, as measured by the Tabor abrasor with 1000-gm CS10 wheel, is 0.7 to 1.5 mils per 1000 revolutions.

Hardness — Coatings deposited from solvent solutions show a pencil hardness of 2H, and a Sward hardness of around 40. Linings from sheet or plastisols are available in Shore A durometer hardnesses of 20 to 100.

Aging—Properly formulated vinyls demonstrate excellent resistance to aging in air or oxygen and have good resistance to cracking, checking and chalking under direct exposure to sunlight and to natural weathering. Unpigmented vinyls are not recommended for weather or sunlight exposures, and plastisols often will exhibit yellowing on prolonged exposure to direct sunlight.

Electrical Properties—Clear or substantially unpigmented vinyls have dielectric strengths of 400 to 500 v per mil at 60 cycles and a resistance of 10^{14} to 10^{15} ohm-cm at 30 F. Compounding with materials of inferior electrical properties will lower these values.

Toxicity and Odor—By suitable selection of compounding materials, vinyl barriers can be made odorless and non-toxic.

(Book Reviews on page 180)

Problem-Solvers

HOUGHTON
metal surface
CONDITIONERS

HOUGHTO-CLEAN 313-A—the fast, cost-saving metal cleaner that prepares metal surfaces for finishing, as it cleans! Deposits iron phosphate coating on steel. Provides an "adhesive" surface for paint and lacquer—reduces finishing costs—retards rust.

HOUGHTO-PHOS—the zinc phosphate surface treatment that prepares ferrous metals for more efficient drawing or extruding—and painting. Retards rust while depositing "grainy" coating for economical finishing.

HOUGHTO-BLACK—the handsome jet black metal finish that's done with *one* bath! Thin—won't alter close|tolerance dimensions—yet lasts longer, protects better, costs far less.

HOUGHTON RUST VETO—the industry's most complete line of rust preventives. Includes indoor and outdoor applications—and for parts and products on shelves, in storage, in shipment or in use.

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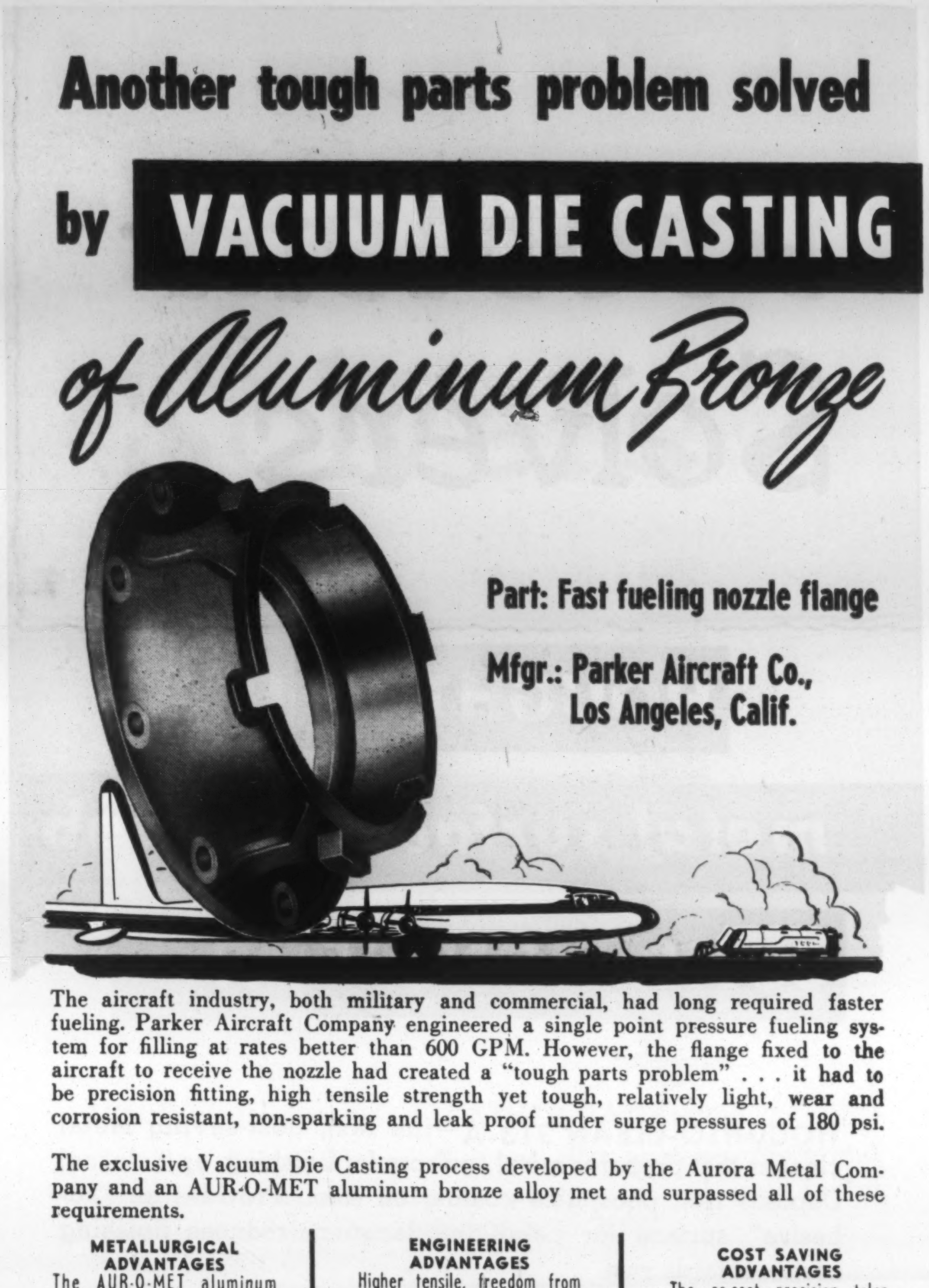

Another tough parts problem solved

by VACUUM DIE CASTING

of Aluminum Bronze

Part: Fast fueling nozzle flange

Mfgr.: Parker Aircraft Co.,
Los Angeles, Calif.

The aircraft industry, both military and commercial, had long required faster fueling. Parker Aircraft Company engineered a single point pressure fueling system for filling at rates better than 600 GPM. However, the flange fixed to the aircraft to receive the nozzle had created a "tough parts problem" . . . it had to be precision fitting, high tensile strength yet tough, relatively light, wear and corrosion resistant, non-sparking and leak proof under surge pressures of 180 psi.

The exclusive Vacuum Die Casting process developed by the Aurora Metal Company and an AUR-O-MET aluminum bronze alloy met and surpassed all of these requirements.

METALLURGICAL ADVANTAGES

The AUR-O-MET aluminum bronze alloy provided the important non-sparking requirement. It also resists corrosion from both fuel and weather, increasing part life. The added density provided by the vacuum process further resists wear caused by continued locking and unlocking of the nozzle.

ENGINEERING ADVANTAGES

Higher tensile, freedom from porosity, structural uniformity and greater density provided by the vacuum method enables locking lugs to support the weight of the hose assembly, and prevent leakage under the 180 psi pressure surges. Thinner sections for weight reduction are possible without sacrificing strength.

COST SAVING ADVANTAGES

The as-cast precision tolerances obtained by the vacuum method reduced the amount of subsequent machining operations. Further savings were effected because the vacuum die castings are free of oxide inclusions, reducing machining time and tool wear.

If you have a "tough parts problem," vacuum die casting of aluminum bronze may be your answer.

Vacuum die casting of aluminum bronze is not a cure-all, but it has proved to be the answer for a wide range of parts-production problems.

Our engineering staff's extensive experience is at your disposal. If you have a specific problem, send prints or specifications . . . we will give them our prompt attention.

Learn more about vacuum die casting in aluminum bronze.
Send today for this free informative brochure.

Aluminum Bronze

AUR-O-MET ALLOYS

Aurora Metal Company
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Representatives In: New York City, Rochester, Cleveland, Cincinnati, Detroit, Grand Rapids, Chicago, Minneapolis, Los Angeles, Boston, Seattle.

For more information, turn to Reader Service Card, Circle No. 446

Contents Noted

Books

Shell Molding and Shell Mold Castings. *By T. C. Du Mond. Reinhold Publishing Corp., New York 22, N. Y., 1954. Cloth, 4¼ by 6¾ in. 128 pp. Price $2.00.*

This is the third in the new Reinhold Pilot Book Series of pocket books designed to present information in condensed form on various new materials and methods. It contains information available from no other source on the shell molding process and will permit potential users of shell mold castings to evaluate the method and determine where and how such castings can be used to advantage.

The book is divided into ten chapters covering advantages and disadvantages of the process; costs; selection factors; designing; comparison with other processes; production of cores; equipment; materials, and applications. A bibliography of selected references is included for those interested in pursuing the subject further.

Written in language which can be readily understood by the chemist, metallurgist and engineer who is not an expert in foundry practice, the book will prove a valuable addition to the library of materials engineers and others whose duties include the selection and specification of metallic materials. It will also prove useful as a college text.

High Vacuum In Industry. *By Morton Grossman and Others. Winchester, Mass., 1953. Paper, 8½ by 11 in. 68 pp. Price $5.00.*

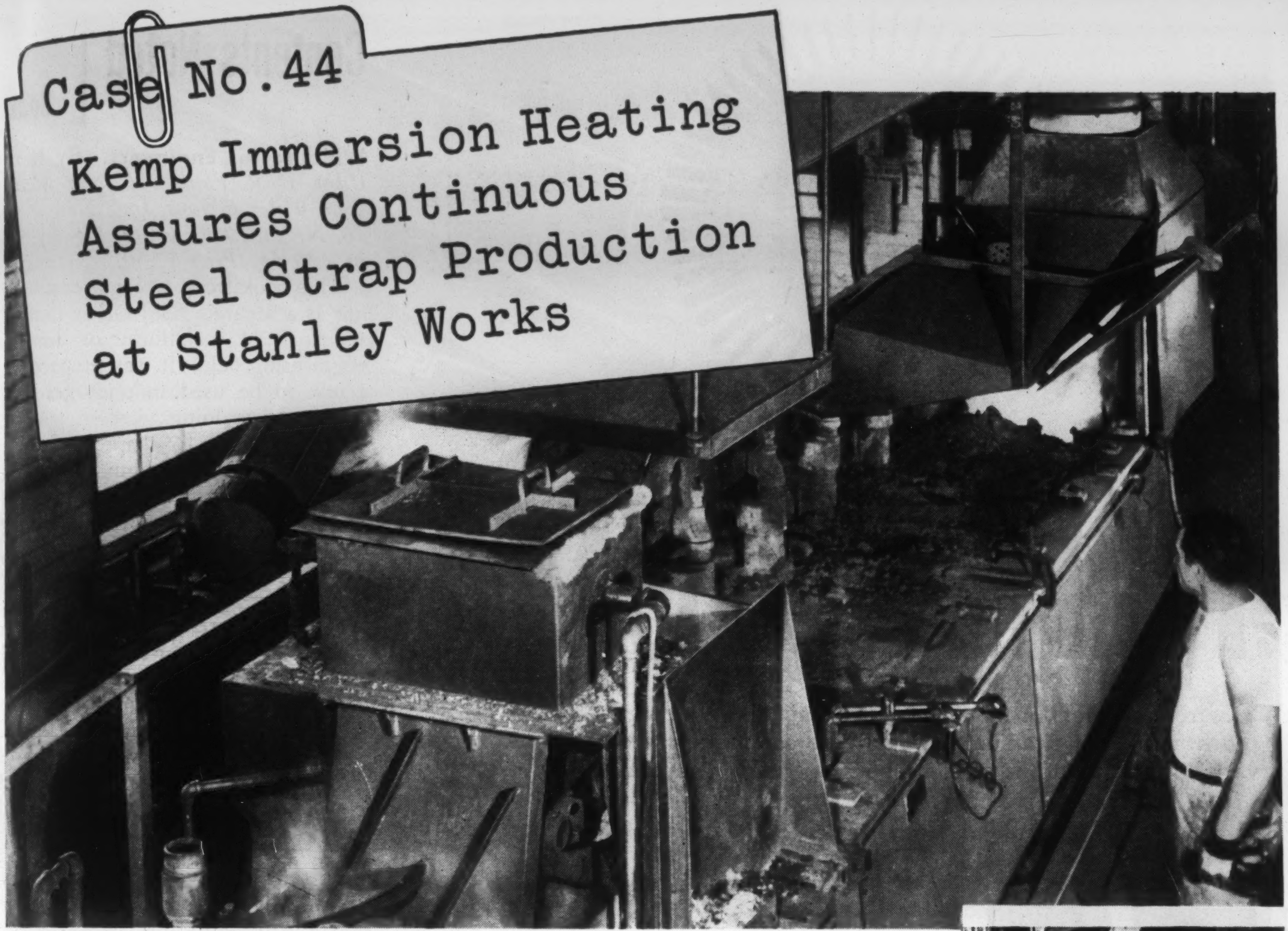
This report, published by a group of students at the Harvard Business School, is a survey of the possibilities for future growth of vacuum processing. After discussing briefly the industry, types of equipment and measurements necessary for vacuum work, the report discusses the various fields in which advances may be expected. These include coating, electronics, metallurgy, chemicals, petroleum and food processing. A selected bibliography is included.

The report has been developed from the results of personal interviews with representatives of various organizations either producing or using high vacuum equipment, from correspondence with others in the field and from the published literature.

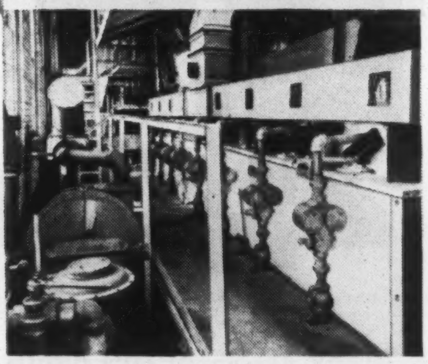
(Book Reviews continued on page 182)

Case No. 44

Kemp Immersion Heating Assures Continuous Steel Strap Production at Stanley Works



How Stanley doubled steel strap capacity overnight . . . slashed fuel costs, too



Rear view of Kemp Pot at Stanley Works shows gas feed lines, fire checks, and the Kemp Carburetor (left). Part of every Kemp installation, this carburetor assures complete combustion . . . without waste . . . without tinkering. Just set it, and forget it.

Today this bustling division of the famous Stanley Works at New Britain, Conn., turns out steel strapping on a 24 hour basis. Starting with raw, high carbon steel on giant spools, strap is semi-annealed, finished, coated and rewound again for shipping in one *continuous* process. New rolls of raw steel are simply spot-welded to the ends of rolls to eliminate any interruption.

Kemp Eliminates Bottleneck

From an output limited by the capacity of a gas underfired pot, production was doubled on the installation of a 32 ton Kemp Immersion Melting Pot. In addition, Kemp's *greater* heating surface, *faster* heat recovery, *lower* dross formation and *accurate* temperature controls meant real savings in fuel costs. In the words of Mr. Harold Heckman, plant foreman, "Through quicker heating of this pot, we are able to maintain production schedules." And unlike underfired pots, Kemp units eliminate open flame hazards and excessive room temperatures.

Let Kemp Help with Your Problems

If you're dissatisfied with your present heating or melting equipment, consult Kemp first before you make any changes. Let Kemp Engineers show you how they can solve your tempering, annealing, descaling or coating problems quickly and easily. Then just like the Stanley Works, you'll be *time* and *money* ahead.

***For more complete facts, ask for Bulletin IE-11. Write:* C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

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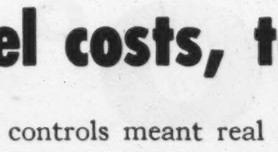

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—for limited applications up to

4000°F

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These Kentanium grades can be extruded and molded into many forms in the powdered state. More intricate forms are machined from pressed slugs. Precise tolerances are obtained by grinding after the forms have been sintered.

A few of the more important applications and potential uses include: bearings and parts subject to high temperatures in contact with liquid metals, nozzle vanes, blades and wheels for gas turbines and jet engines, rod mill guide inserts.

Additional information is contained in our new bulletin entitled: "Kentanium." Write for it. Then contact Kennametal engineers for cooperation on the application of Kentanium to your specific problem. Our sales offices are located in principal cities. KENNAMETAL INC., Latrobe, Pa.

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Contents Noted

Books

Welding for Engineers. *By Harry Udin, E. R. Funk and John Wulff. John Wiley & Sons, Inc., New York 16, N. Y., 1954. Cloth, 5½ by 8½ in. 430 pp. Price $7.50.*

This book treats welding engineering as a separate field rather than as a branch of metallurgy or another engineering field. It was prepared as a text to be used in undergraduate courses on welding.

Divided into 16 chapters dealing with the various welding processes, brazing, weld inspection and mechanical defects encountered in welding, the book also includes a glossary and chapter on problems. Principles rather than practice are emphasized, but the manner of presentation is such that the information will be useful in dealing with a variety of actual welding problems.

Although the book is designed primarily as a text, it will provide a ready reference for those interested in welding.

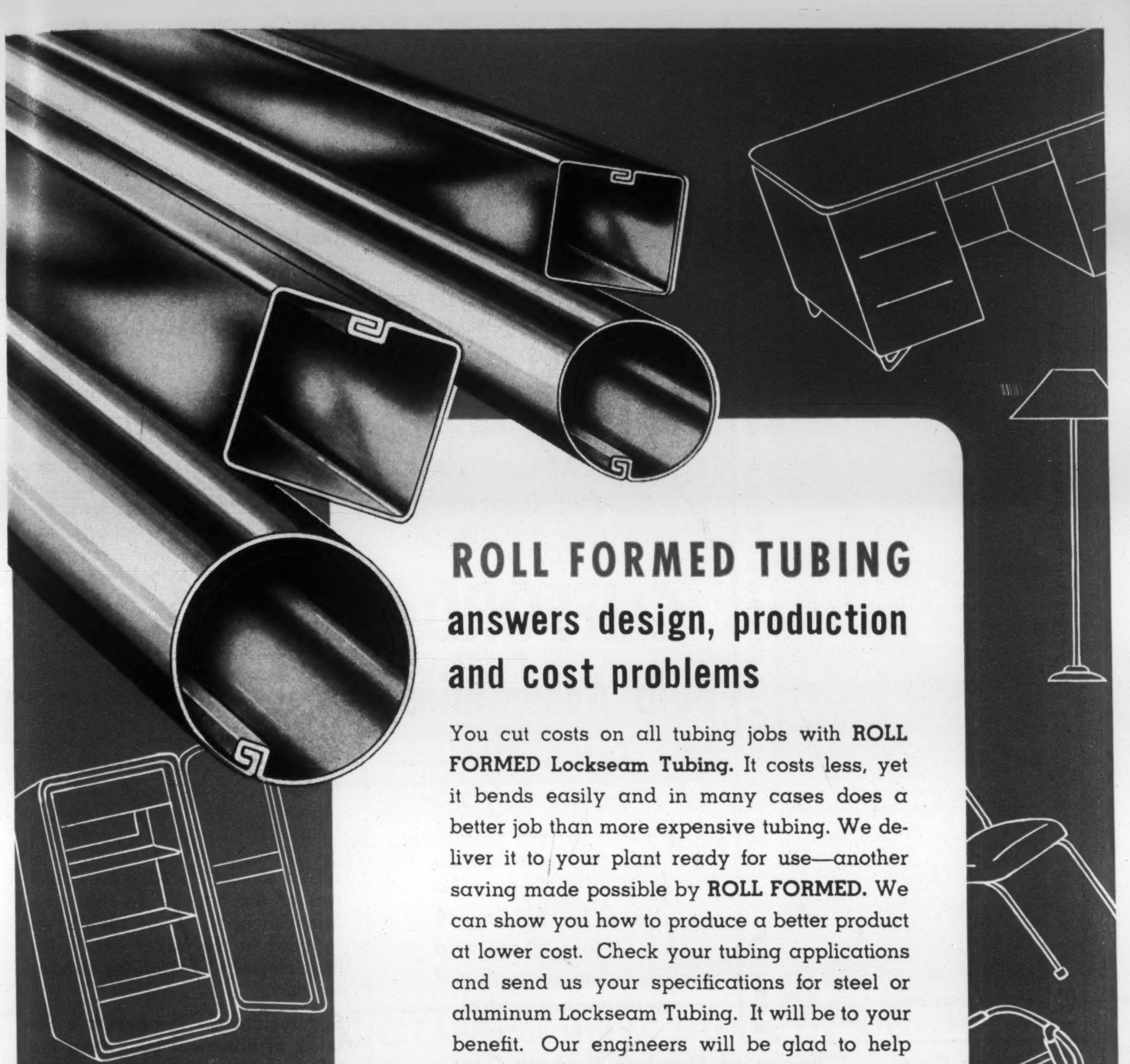
Proceedings Tenth Annual Meeting Metal Powder Association, Vol. I-General Session on Powder Metallurgy; Volume II-Electronic Core Session. *Metal Powder Association, New York, N. Y., 1954. Paper, 6 by 9 in 116 pp. Price Vol. I, $2.50; Vol. II, $1.50; $4.00 for set.*

Included here are the papers presented at the General Session on Powder Metallurgy at the Society's meeting held in Chicago, April, 1954, and the papers presented at the Electronic Core Session.

Heat Treatment of Gray Iron. *By C. O. Burgess. Gray Iron Founders' Society, Inc., Cleveland 14, Ohio, 1954. Paper, 6 by 9 in. 123 pp. Price $5.00, $2.50 to Society members, schools and libraries.*

Written in non-technical language, this manual includes sections on stress relieving, annealing, induction hardening, flame hardening, full hardening, tempering and other heat treating procedures. It contains a full description of all known heat treating procedures for the engineer and practical operator. Pictures, graphs and tables are also included and the many commercial examples of heat treated castings will suggest numerous applications where heat-treated gray iron can be utilized to improve production, quality and economy.

Deterioration of Materials. *Edited by G. A. Greathouse and C. J. Wessel. Reinhold Publishing Corp., New*



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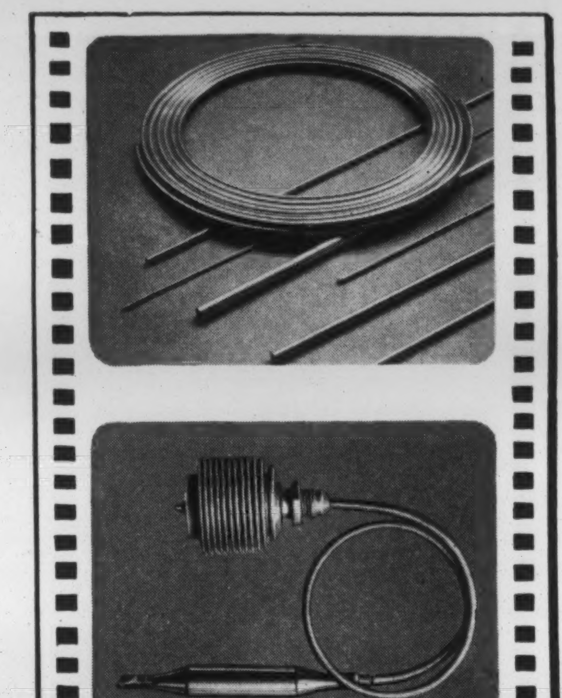

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Bulb Assemblies

Famous CLIFFORD Bellows bulb assemblies have an enviable reputation throughout industry for holding to close tolerances and providing exceptional performance control.

CLIFFORD Manufacturing Company, Division of Standard-Thomson Corp., gives a lot of the credit for this record to UNITED Copper Tubing. Through years of use CLIFFORD has found the product quality in UNITED Copper Tubing unequalled. Capillary is delivered as called for *when* called for and tubing is clean and dry and easily workable.

CLIFFORD sums up by saying "we know we are getting the best copper capillary and copper tubing available in UNITED".

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Contents Noted

Books

York 22, N. Y. 1954. Cloth, 6 by 9 in. 835 pp. Price $12.00.

Prepared with the collaboration of 24 specialists, this book describes and analyzes the causes of deterioration in materials and presents proven techniques for preventing or retarding such deterioration. Covered in detail are the climatic, physical, chemical and biological agents of deterioration; materials such as metals, wood, paper, textiles, cordage, leather, plastics and rubber, paints, varnishes, lacquers and enamels; electrical, electronic and other equipment; dehumidification; storage and packaging; and toxicological aspects of preservatives used. Appendices are provided on climatic systems and on specifications useful for those doing business with government agencies.

ASTM Standards on Copper and Copper Alloys. *American Society for Testing Materials, Philadelphia, Pa., 1954. Paper, 6 by 9 in. 586 pp. Price $5.00.*

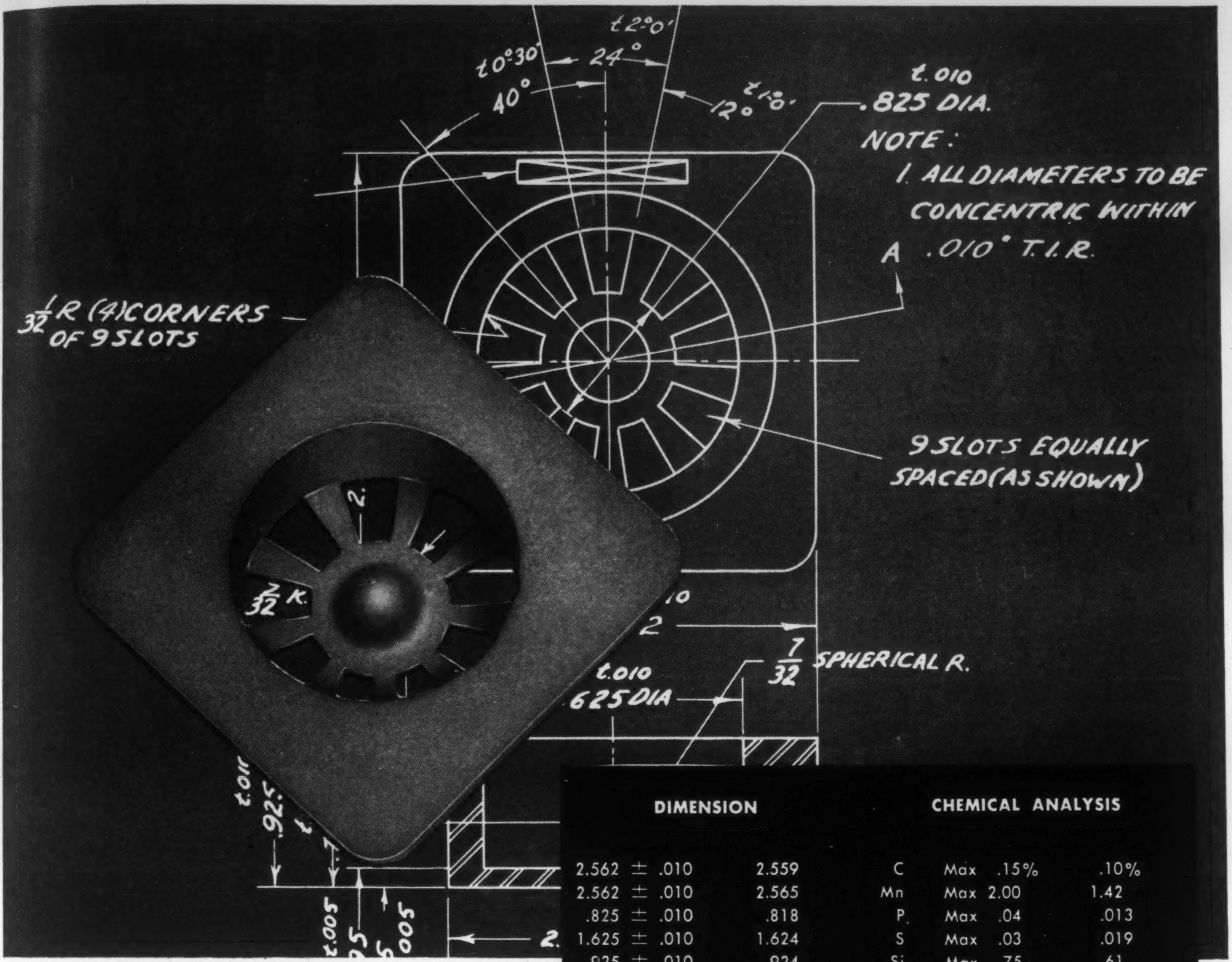
Here in compact, readily usable form, are all of the ASTM Standards pertaining to copper and copper alloys which were developed by ASTM Committee B-5 on Copper and Copper Alloys, Cast and Wrought, and related standards from other committees of the Society. In this special compilation, 50 of the specifications included in the earlier edition have been revised and 8 of the standards are new.

Symposium on Temperature Stability of Electrical Insulating Materials. *American Society for Testing Materials, Philadelphia, Pa., 1954. Paper, 6 by 9 in. 136 pp. Price $2.75.*

Sponsored by ASTM Committee D-9 on Electrical Insulating Materials, this Symposium was presented at the 57th Annual Meeting of the Society held in June, 1954. The 11 papers presented plus photographs, tables and charts, are included here.

Reports

Overstressed Steel Statistical Study of Overstressing in Steel. *G. E Dieter, G. T. Horne and R. F. Mehl, U. S. National Advisory Committee for Aeronautics, Apr. 1954. PB 114034, 34 pp, photographs, diagrams, graphs, tables. Available from the National Advisory Committee for Aeronautics, 1512 "H"*


±2°0'
±0°30'
24°
40°
±1°0'
12°
±.010
.825 DIA.
NOTE:
1. ALL DIAMETERS TO BE CONCENTRIC WITHIN
A .010" T.I.R.
1/32 R (4) CORNERS OF 9 SLOTS
9 SLOTS EQUALLY SPACED (AS SHOWN)
7/32 SPHERICAL R.
±.010
.625 DIA
1/32 R.
±.010
.925
±.005

DIMENSION	
2.562 ± .010	2.559
2.562 ± .010	2.565
.825 ± .010	.818
1.625 ± .010	1.624
.925 ± .010	.924
.700 ± .010	.698
.105 ± .005	.109
2.050 ± .010	2.058
.295 ± .005	.293

CHEMICAL ANALYSIS		
C	Max .15%	.10%
Mn	Max 2.00	1.42
P	Max .04	.013
S	Max .03	.019
Si	Max .75	.61
Ni	12.00-14.00	13.00
Cr	16.00-18.00	17.70
Cu	Max .50	.07
Mo	1.50-2.25	1.96

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Crucible ACCUMET investment castings

for dimensional and metallurgical accuracy . . .

This intricately shaped aircraft instrument part had to be held to rigid specifications both in size and in chemical analysis of the steel.

That's why Crucible ACCUMET® precision castings were used. For Crucible's *lost wax* method of casting, and its long experience as the country's leading producer of fine special purpose steels, combine to bring you accurate castings of the highest quality. But the two tables shown below actually tell the story better than words can. They show how closely ACCUMET castings are held to original specifications.

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4

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St., N.W., Wash. 25, D.C. The effect of overstressing on the fatigue properties of SAE 4340 steel has been studied statistically. In the first part of the study the effect of microstructure on the fatigue damage produced by overstressing was investigated. The second part of the study was an investigation of the effect of a certain amount of overstressing on the endurance limit and its statistics.

Vanadium Potential Use of Vanadium. *Report by the Panel on Vanadium. National Research Council, Division of Engineering and Industrial Research, Minerals and Metals Advisory Board, July 1953. PB 114311, 21 pp, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.25, Photocopy $4.00.*

Stiffness of Cold Rubber Cooperative Laboratory Stiffness Measurements of Rubber at Low Temperatures. *R. A. Ofner, U. S. Arsenal, Rock Island, Ill., Mar. 1954. PB 114047, 33 pp, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.50, Photocopy $5.25.* Stiffness measurements at room and low temperatures were made on ten rubber compounds by four laboratories employing three different test apparatuses Clash-Berg, Gehman, and Werkenthin Bending Beam. The compounds tested were rated on the basis of the calculated values for Young's modulus of elasticity.

Ceramic-Metal Joints Electrical Losses in Ceramic to Metal Seals. *E. W. Ernst and O. T. Purl, Illinois Engineering Experiment Station, Electrical Engineering Research Laboratory, Electron Tube Research Section, Feb. 1954. PB 114049, 46 pp, photographs, drawings, diagrams, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.75, Photocopy $6.50.* Report covers ceramic to metal adhesives, electrical leakage in seals, electrical resistance of contact surfaces and impedance of resonant cavities.

Zirconium Alloys Discussion of the Factors Affecting the Constitution of Zirconium Alloys, an A.E.R.E. Report. *P.C.L. Pfeil, Great Britain Ministry of Supply, Atomic Energy Research Establishment, June 1952. PB 114250, 44 pp, drawings, graphs, tables. Available from British Information Services, 30 Rockefeller Plaza, New York 20, N.Y. $1.40.* Report

SCIENCE MAKES POSSIBLE

FUSED EDGES

U. S. PATS:
2521984
2521985

Vacuum cleaner air filter and a sweat band, both with sealed edges.

Some Present Uses

- Dust shields
- Vacuum cleaner filters
- Powdered soap containers
- Face powder pads
- Insulation
- Clothing lining
- Fluid filters

(the field has barely been scratched!)

Thermoplastic man-made fibres can be felted. American knows how. They can be fabricated into special parts and products with dimensional stability and accuracy for assembly or use without further processing. If desired, fused edge products can be joined to other fabrics instead of by the conventional methods of stitching, adhesives or clamping. The felt within the edges can have any desired porosity, or density characteristics, within wide limits, since such felts can be made entirely of manufactured fibres, or contain mixtures of natural and man-made fibres. Thus these fused-edge felts have great versatility, and are capable of rendering many different services. It will pay you to look into what fused-edge felt products and parts can do for you. Write for information on your company letterhead.

American Felt Company

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24 GLENVILLE RD. GLENVILLE, CONN.

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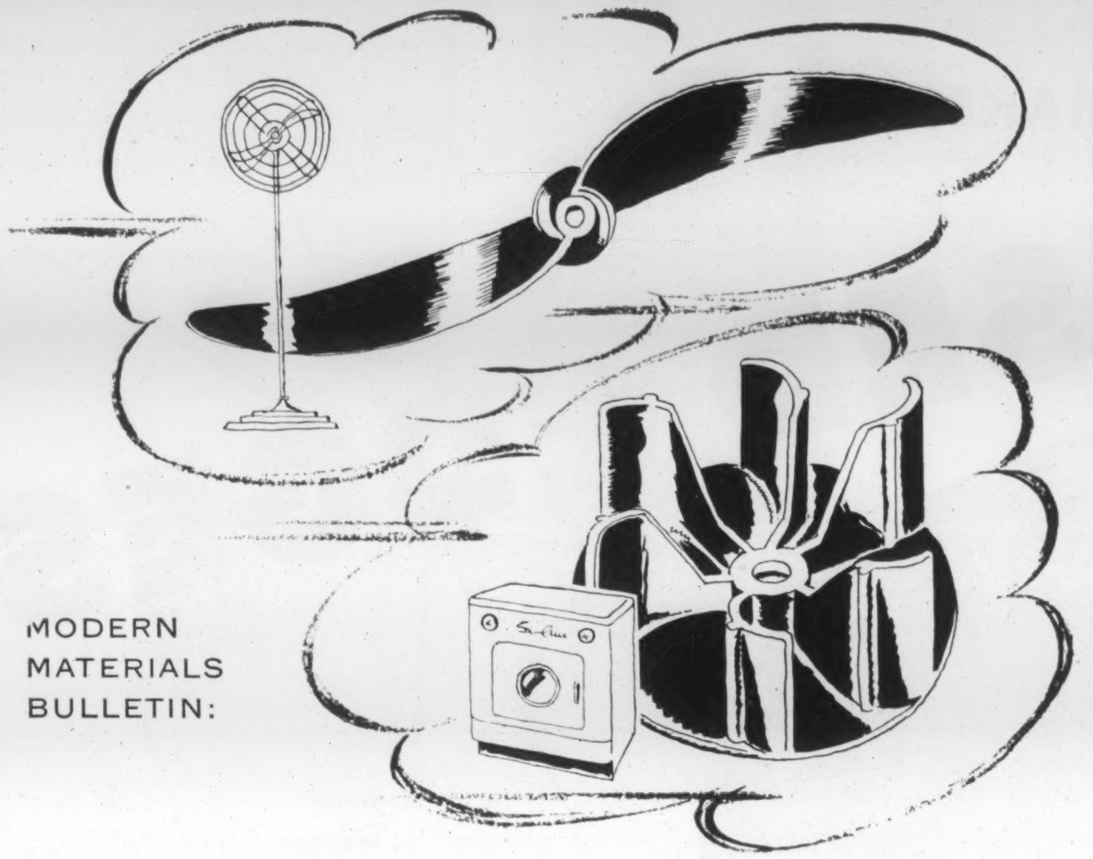

MODERN MATERIALS BULLETIN:

DURES PHENOLICS COULD BLOW PROFITS YOUR WAY

In every field of industry, imaginative application of phenolic plastics creates new profit opportunities. Most versatile of all plastics materials, they are adapted to a tremendous range of engineering requirements.

In both of these air movers, for example, static and dynamic balance of a high degree are obtained with one-piece moldings. Dimensional stability and surface smoothness of the Durez phenolic assures quiet operation of fan propeller—and sizes run up to 35" in diameter. Besides true balance, the clothes dryer blower wheel meets unusual requirements of corrosion and moisture resistance — molded-in contours remain smooth through years of home laundry service.

Whether or not you have used phenolics before, an inquiry into Durez developments could reveal a new way to add product appeal, or to make a process more efficient. A call to Durez brings 33 years of specialized phenolics' experience to your problem. Write for our monthly assembly of new ideas, "Plastics News". . . Durez Plastics & Chemicals, Inc., 1412 Walck Road, North Tonawanda, N. Y.

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MOLDING COMPOUNDS. Structural, electrical, and chemical properties in many combinations.

RESINS FOR INDUSTRY. Bonding, casting, coating, laminating, impregnating, and shell molding.

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includes physical properties of zirconium alloys and British research concerning zirconium alloys in atomic applications.

Creep of Metals Fundamental Studies Related to the Origin and Nature of Creep of Metals. Ninth Technical Report: Recent Observations on the Motion of Small Angle Dislocation Boundaries. *Douglas W. Bainbridge, Choh Hsien Li, Eugene H. Edwards, Jack Washburn, Earl R. Parker, University of California, Institute of Engineering Research, Berkeley, Calif., Aug. 1953. PB 114026, 31 pp, photographs, drawings, graphs. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.50, Photocopy $5.25.* Report covers general discussion of creep in metals, some metallurgical considerations of zinc, plastic deformation of zinc, creep tests and shear stress theory in relation to zinc alloys.

Synthetic Mica Synthetic Mica, a Critical Examination of the Literature. *Rustum Roy, Pennsylvania State College, School of Mineral Industries, State College, Pa., Oct. 1952. PB 111428, 74 pp, diagrams, tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D.C. $2.00.* Report includes a discussion of the crystal structure of mica and the manufacture and properties of mica, including a bibliography.

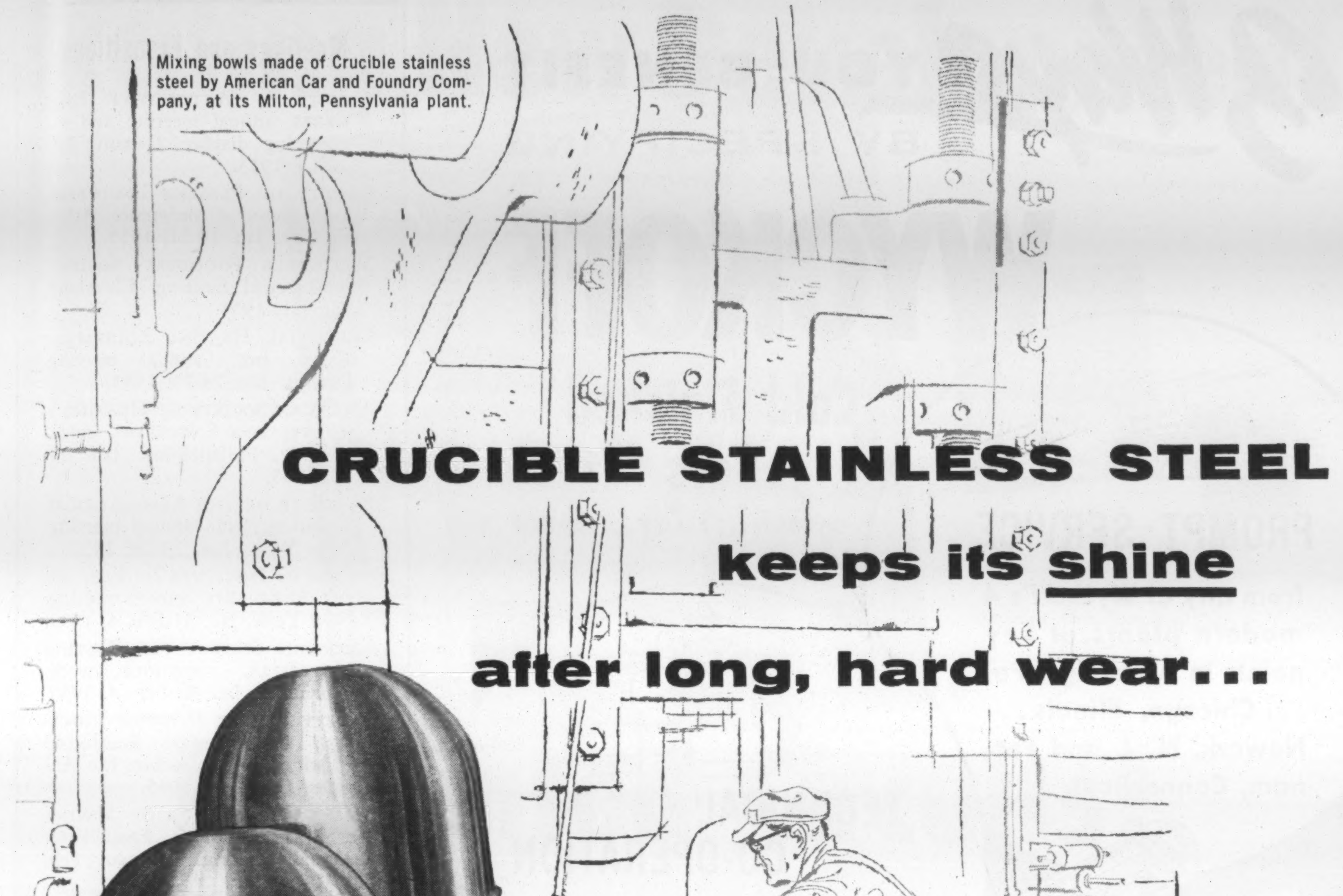
AEC Reports The following reports are available from the Office of Technical Services, Wash. 25, D.C.

Aqueous Static Corrosion of Aluminum Alloys Coupled to Stainless Steel and Zirconium at 350 F. *P. O. Strom, M. H. Boyer and L. H. Litz, Jan. 1954. LRL-74, 13 pp. $.20.*

Enamels for Metals. *J. H. Handwerk and T. N. McVay, Oct. 24, 1951. ORO-47, 92 pp. $.35.*

Corrosion. A bibliography of Unclassified Report Literature. *Robert E. Allen, June 1953. TID-3048, 54 pp, $.55.*

Irradiated Polyethylene Changes in Some Physical Properties of Polyethylene by Pile Irradiation at 80 C, an A.E.R.E. Report. *M. Ross, Great Britain Ministry of Supply, Atomic Energy Research Establishment, Apr. 1954. PB 114692, 15 pp, drawing, graphs, tables. Available from British Information Services, 30 Rockefeller Plaza, New York 20, N.Y. $.65.*



Mixing bowls made of Crucible stainless steel by American Car and Foundry Company, at its Milton, Pennsylvania plant.

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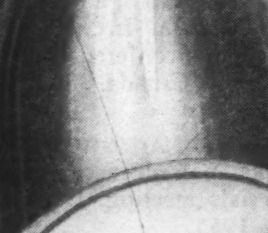
keeps its shine

after long, hard wear...

The fact is stainless steel improves with wear, for the more it is used the harder and smoother the surface becomes. And there is never any surface plating to wear on a stainless product, for stainless steel is *stainless* all the way through.

Yes, Rezistal® stainless is a *natural* for products that must take long hard service, or that must resist corrosion or wear, or stand up under daily cleaning with strong detergents. Take, for example, the stainless mixing bowls shown. They'll give many years of trouble-free service. And their smooth, sanitary surface makes them especially suited to the processing of baked goods, candy, cosmetics or chemicals.

Be sure you take advantage of all the money- and time-saving qualities of stainless steel. And be sure you specify Crucible stainless... made by the country's leading producer of special purpose steels. You'll get fast delivery of the grade and size you need when you call Crucible.



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All types of furnace treated Steels

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Meetings and Expositions

Society of Automotive Engineers, annual meeting and engineering display. Detroit. Jan. 10-14, 1955.

Society of Plastics Engineers, Inc., technical conference. Atlantic City. Jan. 19-21, 1955.

Malleable Founders' Society, semi-annual meeting. Cleveland. Jan. 21, 1955.

Industrial Heating Equipment Assn., Inc., annual meeting. Detroit. Jan. 24-25, 1955.

American Society of Heating & Ventilating Engineers, annual meeting, Philadelphia. Jan. 24-27, 1955.

Institute of the Aeronautical Sciences, Inc., annual meeting. New York. Jan. 24-28, 1955.

American Institute of Electrical Engineers, winter meeting. New York. Jan. 31-Feb. 4, 1955.

American Society for Testing Materials, committee week. Cincinnati. Jan. 31-Feb. 4, 1955.

Society of the Plastics Industry, Inc., annual Reinforced Plastics Div. conference. Los Angeles. Feb. 8-10, 1955.

American Institute of Mining & Metallurgical Engineers, annual meeting. Chicago. Feb. 14-17, 1955.

Society of the Plastics Industry Canada, Inc., annual SPI Canadian conference. London, Ontario, Canada. Feb. 22-23, 1955.

Society of Automotive Engineers, passenger car, body and materials meeting. Detroit. Mar. 1-3, 1955.

National Electrical Manufacturers Assn., winter meeting. Chicago. March 13-18, 1955.

Steel Founders' Society of America, annual meeting. Chicago. March 14-15, 1955.

Society of Automotive Engineers, production meeting and forum. Cincinnati. March 14-16, 1955.

American Society for Metals, Western Metal Congress and Exposition. Los Angeles. March 28-April 1, 1955.

Society of the Plastics Industry, Inc., Pacific Coast section conference. Palm Springs, Calif. April 13-15, 1955.

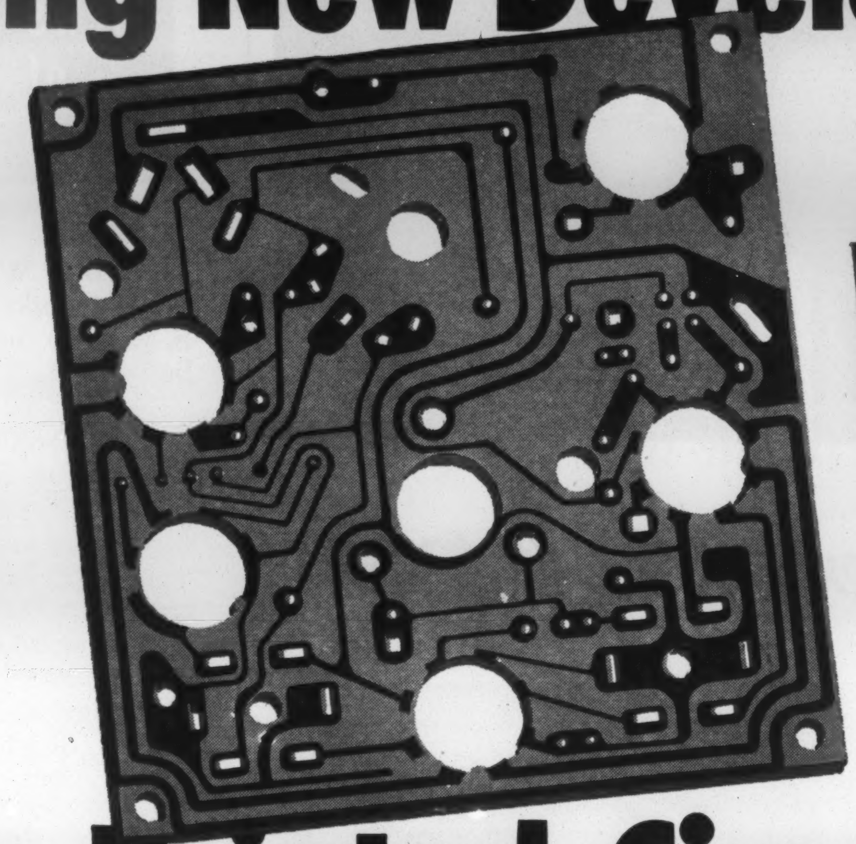
American Society of Lubrication Engineers, annual meeting and exhibit. Chicago. April 13-15, 1955.

Society of Automotive Engineers, aeronautic meeting, aeronautic production forum and aircraft engineering display. New York. April 18-21, 1955.

Metal Powder Association, Annual Meeting. Philadelphia. May 10-12, 1955.

Basic Materials Conference and Exposition. Philadelphia. May 31-June 3, 1955.

Exciting New Development



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Methode Manufacturing Corp.
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in Printed Circuits!

New CuClad* copper-clad laminate offers unequalled bond strength, heat resistance, solderability, punchability, electrical performance!

Here's the foil-clad laminate you've been waiting for! It's CuClad Lamicoid®—made possible by an entirely new concept in bonding material, specially designed equipment developed exclusively by Mica Insulator Company. This new bond and unique bonding method give you unequalled performance that's consistent and dependable from sheet to sheet, lot to lot.

*Trade-mark

You get all these advantages:

A STRONGER BOND WHICH *IMPROVES* WITH AGE AND HEAT
BETTER HEAT RESISTANCE
BETTER REACTION TO HOT SOLDER
BOND ELECTRICALLY EQUAL TO LAMINATE
IMPROVED ARC RESISTANCE
SUPERIOR PUNCHABILITY
UNIFORMITY

and CuClad Lamicoid is competitively priced!

CuClad Lamicoid is available *NOW,* in several grades. Tell us your requirements or problems—or ask to have a Mico Sales Engineer call.

LOOK AT THESE TYPICAL PRODUCTION RUN VALUES ON 6028 XXXP CuCLAD LAMICOID:

BOND STRENGTH—Guaranteed min: 6 lb.; avg. 9 lbs. (90° peel at 2 lbs/min.)

SOLDER TEST—Guaranteed no blisters @ 230-240° C. for 10 seconds, 1" square floated on molten solder

HEAT RESISTANCE—Guaranteed no change at 150° C. for ½ hour in air-circulated oven, air flow parallel to specimen

PUNCHABILITY—Excellent

SURFACE RESISTIVITY, megohms
C-96/35/90 .... 7.3×10^4

VOLUME RESISTIVITY, megohm cm.
C-96/35/90 .... 3.7×10^5

WATER ABSORPTION
1/16" th., E-1/105 + D-24/23
copper on 0.1%
1/16" th., E-1/105 + D-24/23
copper removed 0.7%

MICA *Insulator* COMPANY

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LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Coated Fabrics and Papers) • FABRICATED MICA • ISOMICA ®

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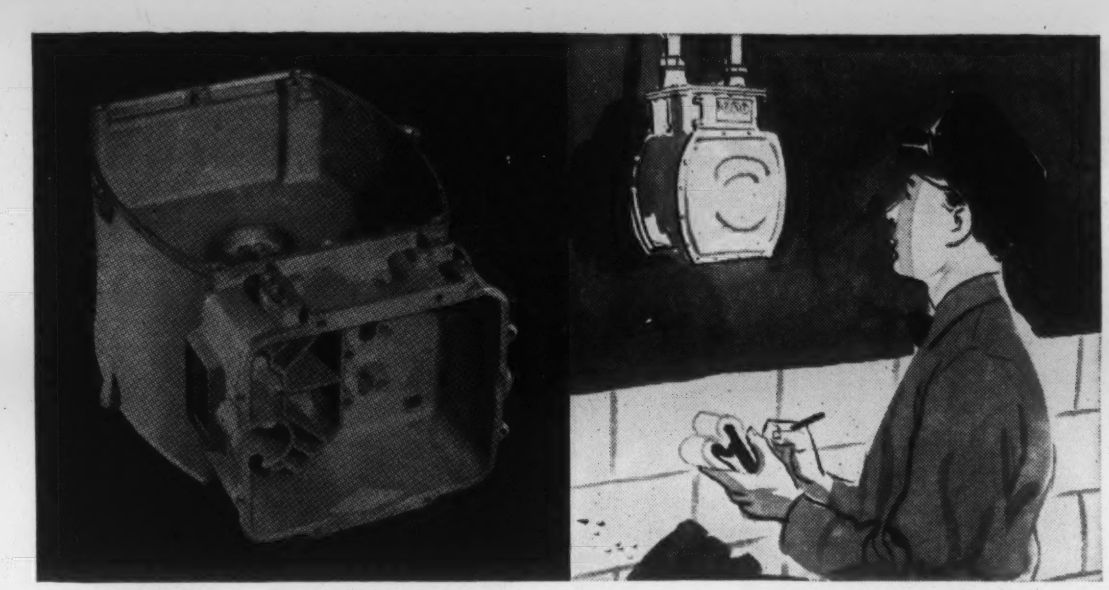
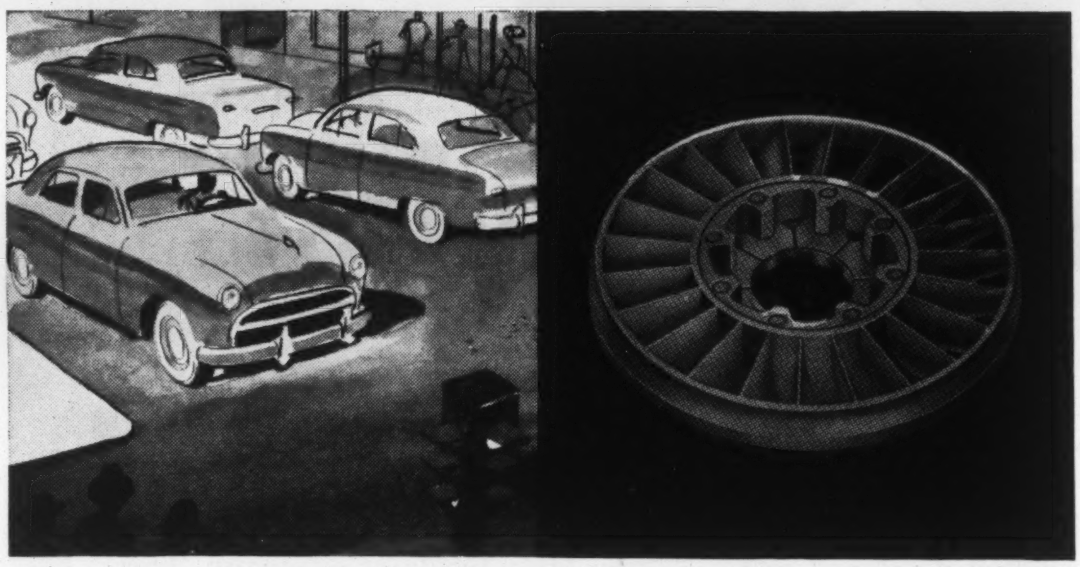


The Meter Reader and the Motorist



Thompson Precision-Engineers Light Metal Castings for All Industry

THE meter reader checking on gas consumption and the motorist patiently waiting for traffic to move have one thing in common — both can count on Thompson Products. The meter reader's dials and the motorist's automobile are each improved by Thompson's versatile Light Metals Division.

In the case of the meter reader, it's the housing in which the dials are set that's produced by Thompson—with the automobile it's any of many parts, including the torque converter stator for the automatic transmission.

Gas meter housings and torque converters are but two of the many light, strong, durable castings designed, developed and manufactured by Thompson for a diversified list of customer uses. Today Thompson is producing light metal castings for such products as buses and garbage disposers; washing machines and jet planes; automobiles and industrial engines; ice scoops and aircraft engines.

Behind this ability to aid all forms of industry are over 50 years experience in research and manufacture of precision metal parts. Regardless of your product, if you use castings, Thompson's creative engineers will gladly show you where and how you can simplify your operations and save on costs with Thompson Light Metals Castings.

For a detailed description of the Thompson Light Metals facilities which are available to you, send for your free copy of "Creative Castings." Just write to Dept. MMN, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio.

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Thompson Products
LIGHT METALS DIVISION
2269 Ashland Rd. • Cleveland 3, Ohio

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news of ENGINEERS COMPANIES SOCIETIES

Harold Wrigley has been appointed works manager, and **Charles S. Basney** new products manager, Barry Corp.

•

Dr. Theodore J. Rowland and **Dr. Milton Stern** have joined the staff of Electro Metallurgical Co.'s Metal Research Laboratories. Both men have been assigned as senior research assistants with the Chemical Research Group.

•

Stanley L. Haines has been appointed director of industrial engineering, American Locomotive Co.

•

Dr. J. M. Salsbury has been named manager of the Textile Resins Research Section of American Cyanamid Co.'s Bound Brook Laboratories. Other Research Division appointments are: **Dr. Charles Maresh** as manager of the Bound Brook Service Section, and **Dr. Charles R. Witschonke** as technical assistant to the director of the Research Service Dept. at the Stamford, Conn., Laboratories.

•

Henry A. Holberson has been elected vice president and general manager, Youngstown Metal Products Co., a subsidiary of Youngstown Sheet and Tube Co.

•

C. Paul Fortner has been elected vice president in charge of research and development, Plax Corp.

•

August E. Klinger has been named president of Buffalo Steel Corp., now being formed to take over the Buffalo Steel Div., H. K. Porter Co., Inc., recently purchased by Rochester interests.

•

John B. Seastone has been appointed research and development manager for the Metals Div., Olin Mathieson Chemical Corp. **C. G. Merritt** has been appointed technical advisor to Mr. Seastone.

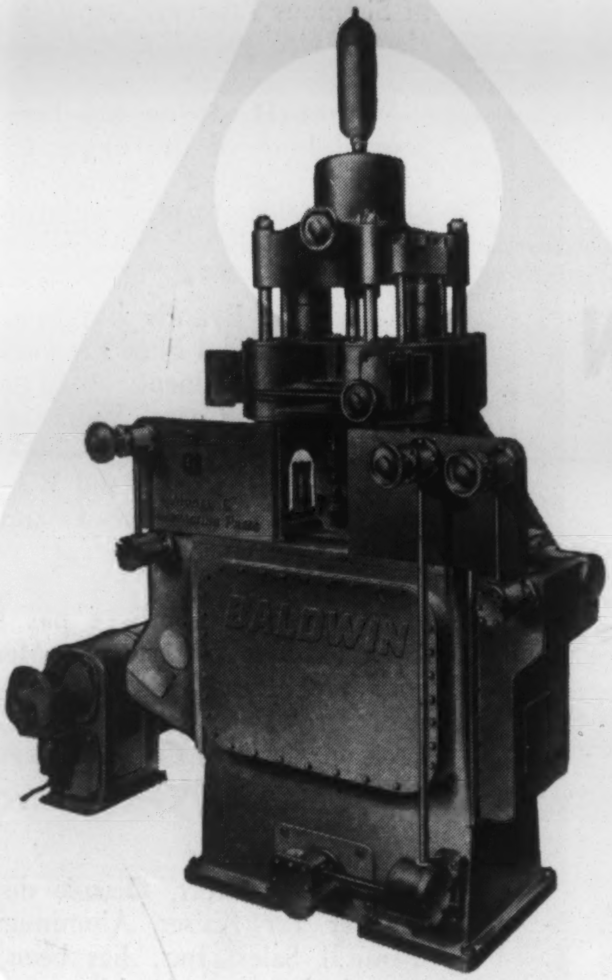
•

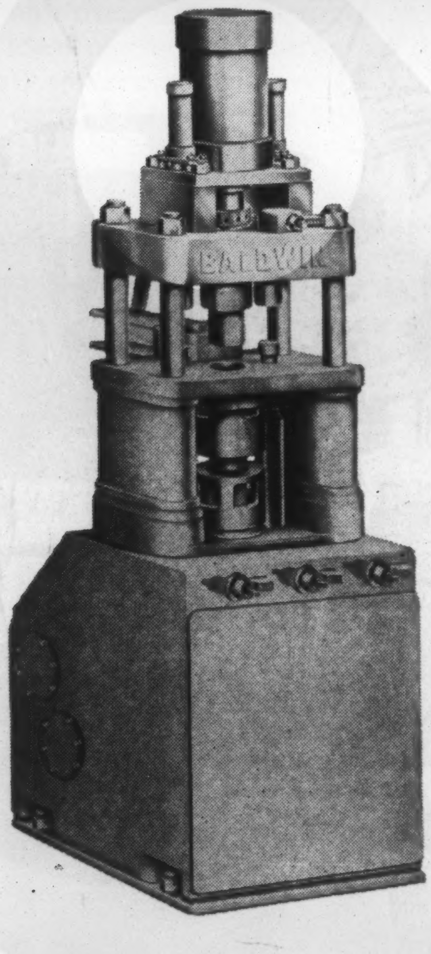
Stephen A. Keller has been named general manager of the Heiland Div., Minneapolis-Honeywell Regulator Co. The Heiland Div., formerly Heiland Research Corp., was recently purchased by Honeywell.

(Continued on page 192)

HYDRAULIC HEAD

avoids overloading, controls densities, in new Baldwin powdered metal presses . . .





YOU'LL GET a whale of a lot more by specifying a Baldwin Model "L" or Model "C" for your next powdered metal press. Why? Because these new Baldwin presses are the very first designed specifically for compacting powdered metals.

Here's just one of the reasons why it'll pay you to standardize on Baldwin to take care of your pressing needs . . .

Both the 50 ton ("L") and 100 ton ("C") presses feature a hydraulic head which supplies opposing pressure for the upper punch. It works like this: if the compressing pressure exceeds the setting of the hydraulic accumulator, the upper punch "gives" to the limit of the setting . . . that enables the hydraulic head to benefit you in three very vital ways:

1. It prevents overloading of the press, thus prolonging the life of both tools and press.
2. It makes it possible to compact powdered metal parts to more uniform densities.
3. It permits use of more delicate tools.

For copies of new bulletins with full technical information on Models "L" and "C" please write to our Department 4523, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pennsylvania.

BALDWIN-LIMA-HAMILTON

Philadelphia 42, Pa. • Offices in Principal Cities

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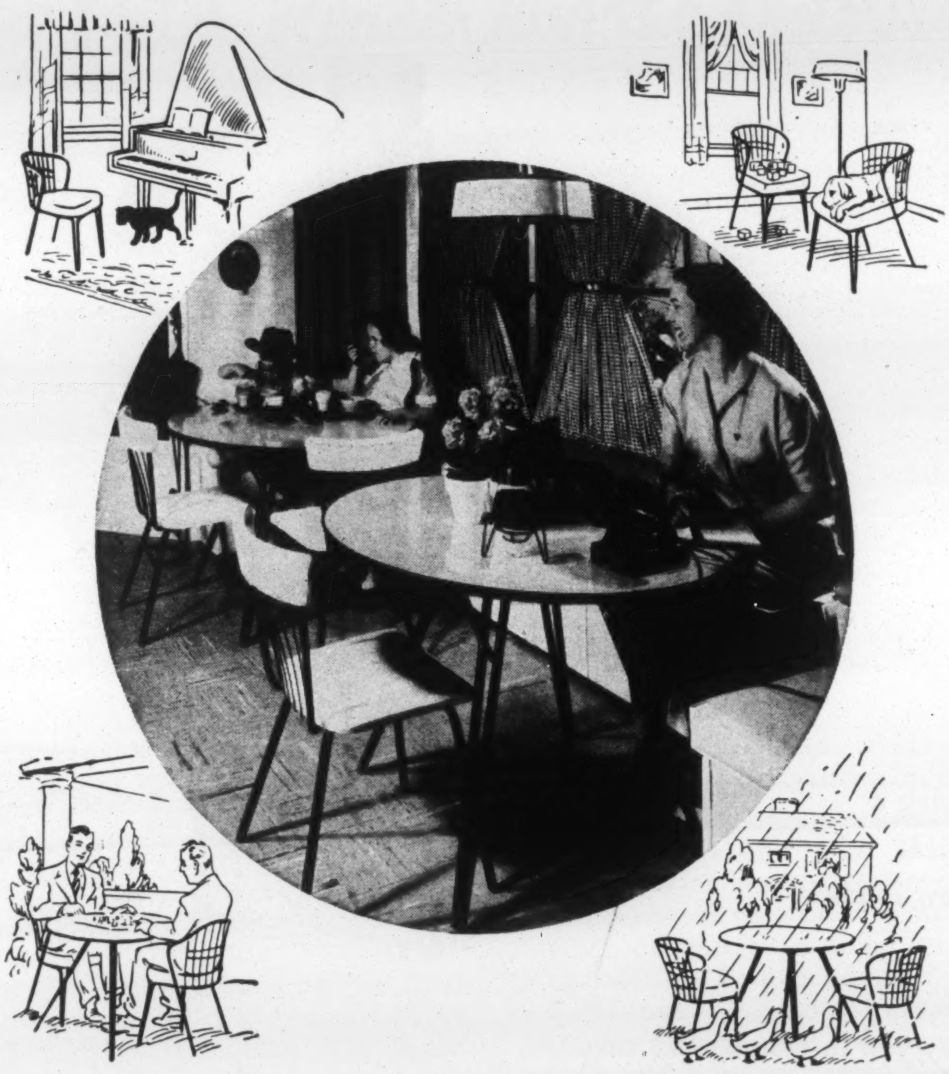
DAYSTROM
FURNITURE
is Granodized
WITH "GRANODINE"®
FOR EXTRA PROTECTION



Long noted for beauty in styling, Daystrom Furniture also boasts that its black and golden bronze Coloramic can take it. Here's why: sturdy metal parts are Granodized before painting.

Granodizing is a protective phosphate treatment that bonds Daystrom's exclusive Coloramic finish to steel. Beautiful Daystrom Furniture is truly built for a lifetime of rugged use.

CHEMICALS
ACP
PROCESSES

"GRANODINE"® anchors the finish.

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PENNA.
DETROIT, MICH. NILES, CALIF. WINDSOR, ONT.

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news of | ENGINEERS

Harry H. Rose, general manager of Simmons Fastener Corp., has been elected vice president and director.

•

Walter H. Prine has been appointed head of the Electroplating-Chemical-Catalyst Section of the Nickel Sales Dept., International Nickel Co., Inc.

•

Dr. W. H. Brandt has been appointed to head a New Products Engineering department at Westinghouse Electric Corp. Work of the new department will be closely coordinated with that of the Westinghouse Research Laboratories and the Materials Engineering Dept.

•

Ronald D. Gumbert has been appointed vice president, Mercast Corp. Mr. Gumbert will continue as executive vice president of Alloy Precision Castings Co., a Mercast licensee in which Mercast has an important interest.

•

M. C. Crockett, Detroit district manager for Kaiser Aluminum & Chemical Sales, Inc., has been appointed to the new position of automotive industry manager.

•

Dr. Kenneth C. D. Hickman, formerly vice president in charge of research at Distillation Products Industries, and consultant to the Eastman Kodak Co., has been appointed research consultant to the Consolidated Vacuum Corp.

•

Jefferson J. Davis has been appointed vice president in charge of Products Divs., Electric Steel Foundry Co.

•

Robert Insley has been named chief product engineer for the Aircraft Engine Div., Ford Motor Co. Mr. Insley has been manufacturing vice president of Continental Aviation & Engineering Corp.

•

William W. Kuyper has been appointed manager-manufacturing engineering of the Large Steam Turbine-Generator Dept., General Electric Co.

•

Joseph J. Swigart has been named general manager of Vitro Rare Metals Co. Mr. Swigart replaces **Franklin H. Bivins** who becomes assistant to the executive vice president.

(Continued on page 196)

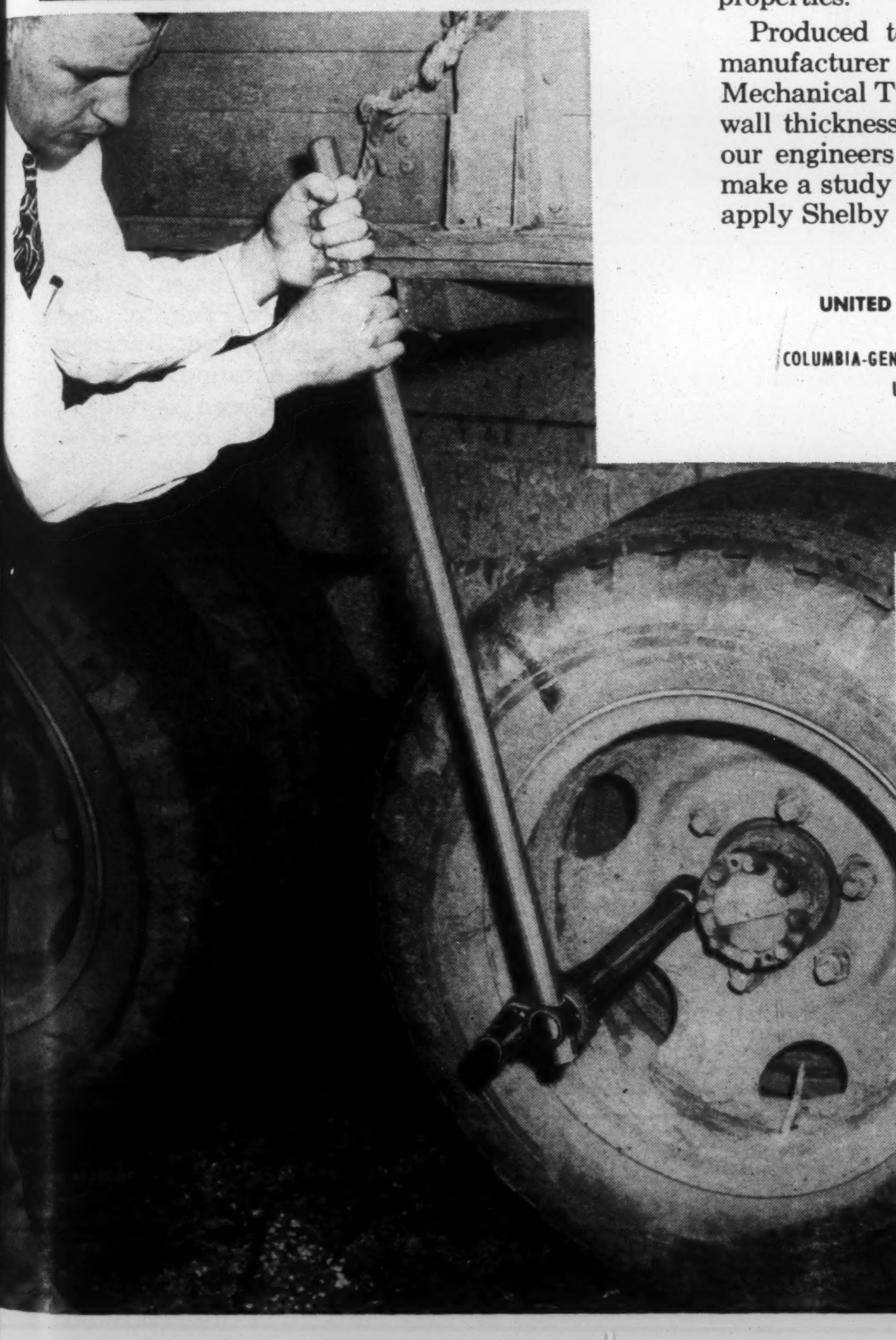
Shelby and Sweeney tame a tough nut

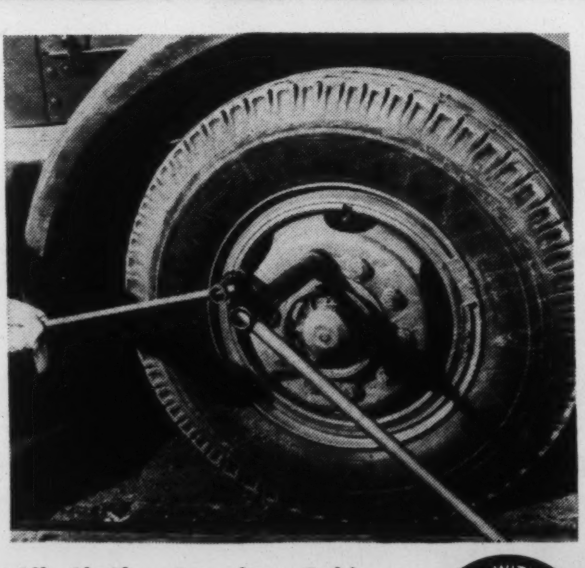
• The Sweeney POWERENCH is a rugged nut turning tool specifically designed with geared action for tightening or loosening the nuts on dual wheels, aircraft propeller shafts, diesel engine cylinder heads, railroad locomotives, and for countless other heavy-duty applications.

Super tough equipment calls for super strong materials. That's why Shelby Seamless Mechanical Tubing—in sizes from 1⅛ in. O.D. to 5⅝ in. O.D.—is used in the manufacture of POWERENCH assemblies. The great strength, complete uniformity, and extreme dimensional accuracy of Shelby Seamless make it the ideal mechanical tubing for the fabrication of such heavy-duty materials. Moreover, it is safe and workable—possessing excellent machining and superior welding properties.

Produced to exacting standards by the world's largest manufacturer of tubular steel products, Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. Call on our engineers for recommendations. They will be glad to make a study of your particular requirements and help you apply Shelby Seamless to your specifications.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK





All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

WALLS WITHOUT WELDS

USS SHELBY SEAMLESS MECHANICAL TUBING

USS

4-12

UNITED STATES STEEL

PROTECTIVE COATINGS TWELVE TIMES AS THICK... WHEN YOU USE

... ATLAS *NEELIUM*®

With Atlas Neelium, you apply *individual coats as much as twenty mils thick*. You use the same amount of Neelium as other materials, but it takes considerably less time . . . considerably less labor . . . for a more resistant coating of equal thickness.

Here is the sensible approach to a better protective coating at a lower overall cost. Neelium cuts labor expense which usually runs 3 to 5 times the cost of good coating materials.

Neelium is an ideal coating both chemically and physically. It is Neoprene based, and provides a surface that is inert and impervious to an extremely broad range of corrosives in the form of fume or splash. It resists acids, alkalies, oils, greases, salts, sunlight and weathering. Neelium cures at room temperature to a tough, resilient film with remarkable abrasion resistance, assuring long service under the hardest conditions.

Write for full information. *Request Bulletin 7-55E.*

ATLAS PRODUCTS STAND
... between your process and corrosion

ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN PENNSYLVANIA
HOUSTON 1, TEXAS

Corrosion-proof: *Cements • Coatings • Vessel Linings • AMPCOFLEX®*

For more information, turn to Reader Service Card, Circle No. 462

news of ENGINEERS

J. H. McElhinney, Vice President in Charge of Operations, Wheeling Steel Corp., has been appointed a member of an Engineering Council to advise and assist in the development of the Schools of Engineering and Mines at the University of Pittsburgh.

•

Dr. R. C. Gibson, formerly technical director, Parker Rust Proof Co., has been promoted to assistant vice president of the company. Dr. Gibson is succeeded by **E. W. Richards.**

•

William B. Freeman, missile engineer and former Marine Corps Development Center staff officer, has joined TEMCO Aircraft Corp. to head a new Engineering Systems Research and Development Div.

•

Bruce Cramer has been appointed refractories engineer by Norton Co.

•

Gerald H. Mains, formerly laboratory director of the company's Phenolite Div., has been chosen to head National Vulcanized Fibre Co.'s new research and development laboratory at Yorklyn, Del. Assisting Mr. Mains will be **Alfred J. Green,** as manager of the new project. **Frederick L. Stiegler** will be in charge of the Paper and Fibre Section, while **Joseph C. Pesce** will head up the Phenolite Section.

•

Dr. Robert L. Womer has been named vice president, Speer Carbon Co.

•

George D. Gotschall has joined Steel Improvement & Forge Co. as manager of its newly established Research and Development Dept.

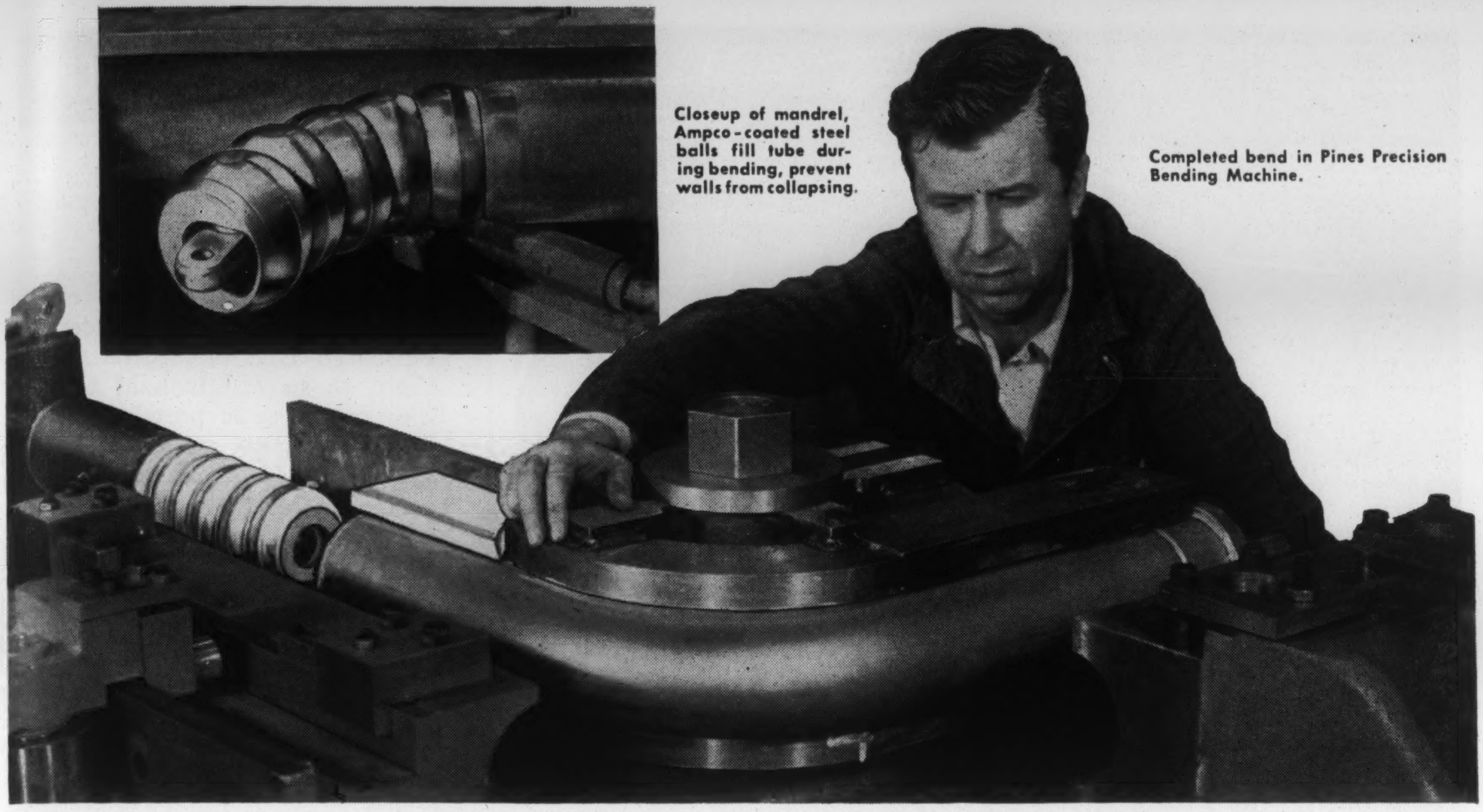
•

Rudolph W. Glasner has been elected a director and vice president of Pressed Steel Car Co., Inc. Formerly president of the Clearing Machine Corp., which was recently acquired by Pressed Steel Car Co., Mr. Glasner will continue to manage the operations of Clearing Machine as a division of Pressed Steel Car Co.

•

Virgil B. Pettigrew, formerly general supervisor in charge of scheduling and change control at TEMCO Aircraft Corp., has been appointed assistant manager of manufacturing control.

(Continued on page 198)



Closeup of mandrel, Ampco-coated steel balls fill tube during bending, prevent walls from collapsing.

Completed bend in Pines Precision Bending Machine.

Pines Engineering licks "impossible" job

. . . bends ultra-thin stainless tubing
. . . cuts airplane costs $14,000
thanks to **AMPCO* METAL**

AIRCRAFT engineers said that cold bending of thin-wall tubing sections for engine and airframe components was impossible — that it couldn't be done. But Pines Engineering Co., Aurora, Illinois, went to work anyway. It developed a precision bending machine that makes smooth, sharp bends to 10″ centerline radius in up to 5″ diameter x .025″ wall stainless tubing — bends that are cutting airplane costs up to $14,000 each.

Pines selected Ampco Grade 20 wiper dies and Ampco-coated mandrels for their new precision machine to resist the tremendous pressures developed in this bending operation. Here's what they say:

"Ampco eliminates the problem of pickup on the mandrel and wiper die when bending stainless steel tubing. And Ampco provides a hard-wearing surface that enables the production of thousands of bends before dies have to be refitted."

And if you draw, form, or bend stainless, pickled carbon steel — or many other metals — here's what *you* get with Ampco dies:

Little or no pickup. You eliminate all the expense of redressing steel dies — redressing that is necessary because of scratching, galling, or pickup. Idle time is cut — and your line keeps moving at top production.

Low finishing costs. You end galling, loading, scratching, die marks. No more problems with big scrap losses. You reduce expensive finishing time.

This remarkable copper-base alloy pays off on your drawing or forming line with longer life, lower costs, less operating grief. Get all the facts on cost-saving Ampco dies from your nearby Ampco field engineer or mail the coupon.

Tear out this coupon and Mail Today!

LET AMPCO PROVE ITS ~~METAL~~ *mettle*

AMPCO®
Sole producer of genuine Ampco Metal

Ampco Metal, Inc.
MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

*Reg. U. S. Pat. Off.

Ampco Metal, Inc., Dept. MA-12, Milwaukee 46, Wisconsin
I'd like to know more about time- and money-saving Ampco dies. Please send me more information.

Name.. Title....................

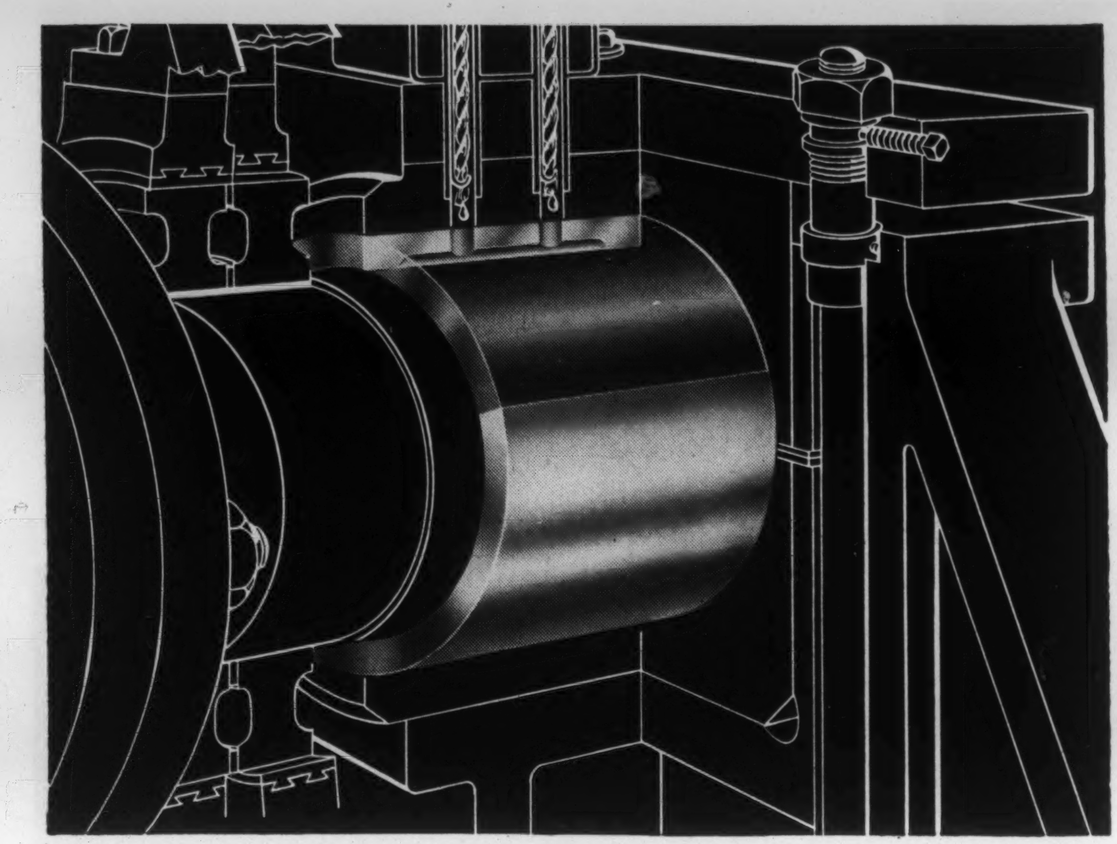
Company..

Company Address..

City.. (..........) State....................

D-39A

• For more information, turn to Reader Service Card, Circle No. 437



THE WAY TO CUT...

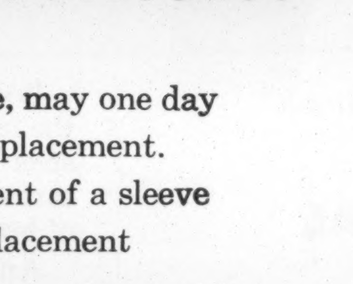
Cost of replacement

Any bearing, regardless of type, may one day reach the point where it requires replacement. If this point is reached the replacement of a sleeve bearing is far less costly than the replacement of any other type of bearing.

Disassembly and removal of the original bearing, installation and reassembly with the new bearing are simpler, quicker and therefore less costly and the cost of the sleeve bearing itself is moderate compared to the cost of other types.

The user of equipment which you design and build will appreciate these advantages of a sleeve bearing.

There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.



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BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

The Bunting Brass & Bronze Company • Toledo 1, Ohio

Branches in Principal Cities • Distributors Everywhere

For more information, turn to Reader Service Card, Circle No. 419

news of | ENGINEERS

Raymond H. Matthews has been appointed chief engineer of Fenwal, Inc.

•

John F. Lott has been elected president, Fort Duquesne Steel Co., Pittsburgh Div. of Federated Steel Corp., to succeed **Donald C. Lott** who continues as president of the parent company.

•

George M. Cleary has been appointed chief engineer, Precision Thermometer & Instrument Co.

•

Max A. Minnig has been named executive vice president, Witco Chemical Co.

•

Alfred P. Sloan, Jr., chairman of the board, General Motors Corp., has been selected as the 1954 recipient of the Hoover Medal.

•

Robert Grant has been promoted to vice president—manufacturing, Standard Products Co.

•

James H. Moore has been named general manager, Vacuum Metals Corp.

•

N. C. Fick has tranferred from the Office of the Secretary of Defense to the Executive Office of the President, Office of Defense Mobilization. Mr. Fick will be Executive Officer of the Titanium Administrative Committee.

•

Clifton T. Foss has been named assistant general manager, Arma Div., American Bosch Arma Corp.

•

John A. Sullivan has been elected president of Tuttle & Kift, Inc., Ferrod Manufacturing Co. and Ferro Electric Products, Inc., all wholly owned subsidiaries of Ferro Corp. Mr. Sullivan replaces **C. D. Clawson** who will assume full time duties as president of the parent corporation.

•

P. S. Hoffman, Jr. has been elected vice president in charge of manufacturing, Donegal Manufacturing Corp.

•

Charles T. Zaoral, vice president in charge of operations and a director of the New York Air Brake Co., has been elected president of the company. **Bernard Peyton,** formerly president, was made chairman of the board.

(News of Companies on page 200)

Fabricated by Mercury Plastics Corp.

Perfect cover-up

Another Case for U.S. Royalite

A "perfect" cover for Universal Winding Co.—one of the nation's leading makers of textile winding machines—had to do *more* than just cover part of the machine.

It had to be tough enough to take constant use, a good deal of *ab*use. It had to be *tight-sealing... good-looking... free of lint-trapping areas*... and relatively *inexpensive*.

Universal found Royalite covers designed and fabricated by Mercury Plastics Corp. of Chicopee, Mass., were *all* this... *and more!*

Covers are easily formed from Royalite sheets over inexpensive tools, with no extra finishing operations required. They are much less expensive than the metal covers formerly used.

What's more, U. S. Royalite brought still other advantages. Its *integral color* matches the machine, can't chip or scratch off. It is *quiet* to handle, and deadens machine noise. Its *formability* allowed an undercut to seal out dirt. And its *flexibility* ended the need for screws or other fastening devices—the cover simply snaps in place!

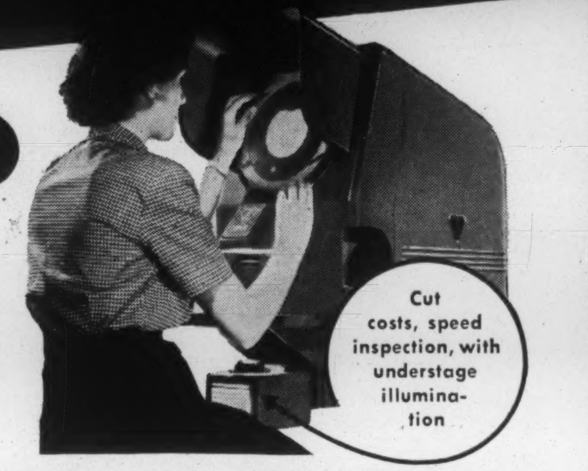
Whether *you* have a *specific* component or cover problem, or just an *idea* that a certain piece of equipment might be improved, it *will pay you to check on U. S. Royalite!*

U.S. ROYALITE®
TOUGH PLASTIC PRODUCTS

UNITED STATES RUBBER COMPANY
2638 NORTH PULASKI ROAD, CHICAGO 39, ILLINOIS

For more information, turn to Reader Service Card, Circle No. 385

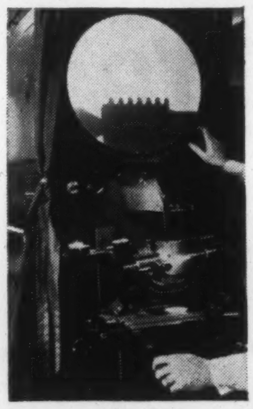
HOW you can meet close tolerances on parts like these!



①

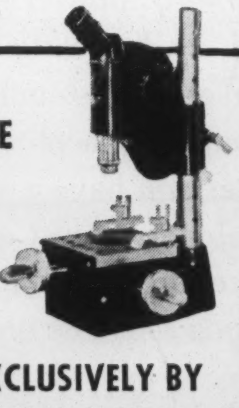
Bausch & Lomb BENCH COMPARATOR
Save every way! No costly holding fixtures needed for most work. No time-wasting set-up. Easy operation quickly provides vivid screen image, reveals costly production errors. Micrometer stage (optional) reads to .0001″.

②



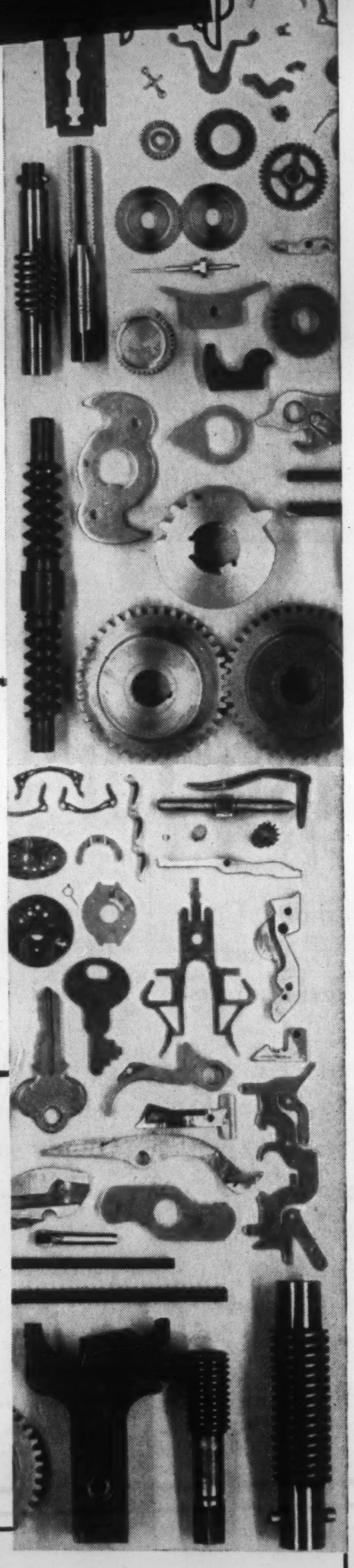
Bausch & Lomb CONTOUR MEASURING PROJECTOR
Quickly, easily shows sharp silhouettes or detailed surface views on 18″ screen . . . for inspection, comparison, or highest precision measurements. Linear readings to .0001″; angular, to 1 minute of arc.

③



Bausch & Lomb TOOLMAKERS' MICROSCOPE
Quickly measures or inspects opaque or transparent objects of any contour. Linear readings to .0001″; angular, to 1 minute of arc.

SOLD AND DISTRIBUTED EXCLUSIVELY BY THE DoALL COMPANY For full information call your local DoALL Sales-Service Store, or write: The DoALL Company, 254 N. Laurel, Des Plaines, Illinois.



BAUSCH & LOMB
SINCE 1853

Quality Control
INSTRUMENTS

news of COMPANIES

Tabor Manufacturing Co. has become a division of **Turbo Machine Co.**

•

Inland Steel Co. has announced plans for an expansion of more than 60 per cent in its galvanized steel sheet capacity. A third continuous line will be installed at the Indiana Harbor Works.

•

Wooldridge Manufacturing Co. has established a Plate and Tank Div. at its Sunnyvale, Calif. plant.

•

Formica Co.'s plant expansion at Evendale, O., is scheduled for completion in January.

•

General Electric Co. recently officially opened its welding plant at York, Pa. The plant is headquarters for G-E welding products and contains manufacturing facilities that make it one of the most modern of its kind.

•

Quaker Rubber Corp. has announced that its West Coast operations and its recent acquisition, **Pioneer Rubber Mills,** will be merged under the name of Quaker Pioneer Rubber Mills, Div. of **H. K. Porter Co., Inc.**

•

Allegheny Ludlum Steel Corp. officially completed a nine-year rebuilding and expansion program by putting into production a new tandem cold rolling mill at its Brackenridge, Pa., plant.

•

Magnecord, Inc. stockholders have approved the purchase of all the outstanding stock of **Davies Laboratories, Inc.** Davies will continue operations as a wholly-owned subsidiary of Magnecord.

•

Glidden Co. recently dedicated its new paint and varnish plant at Ville LaSalle, a Montreal suburb, Quebec, Canada.

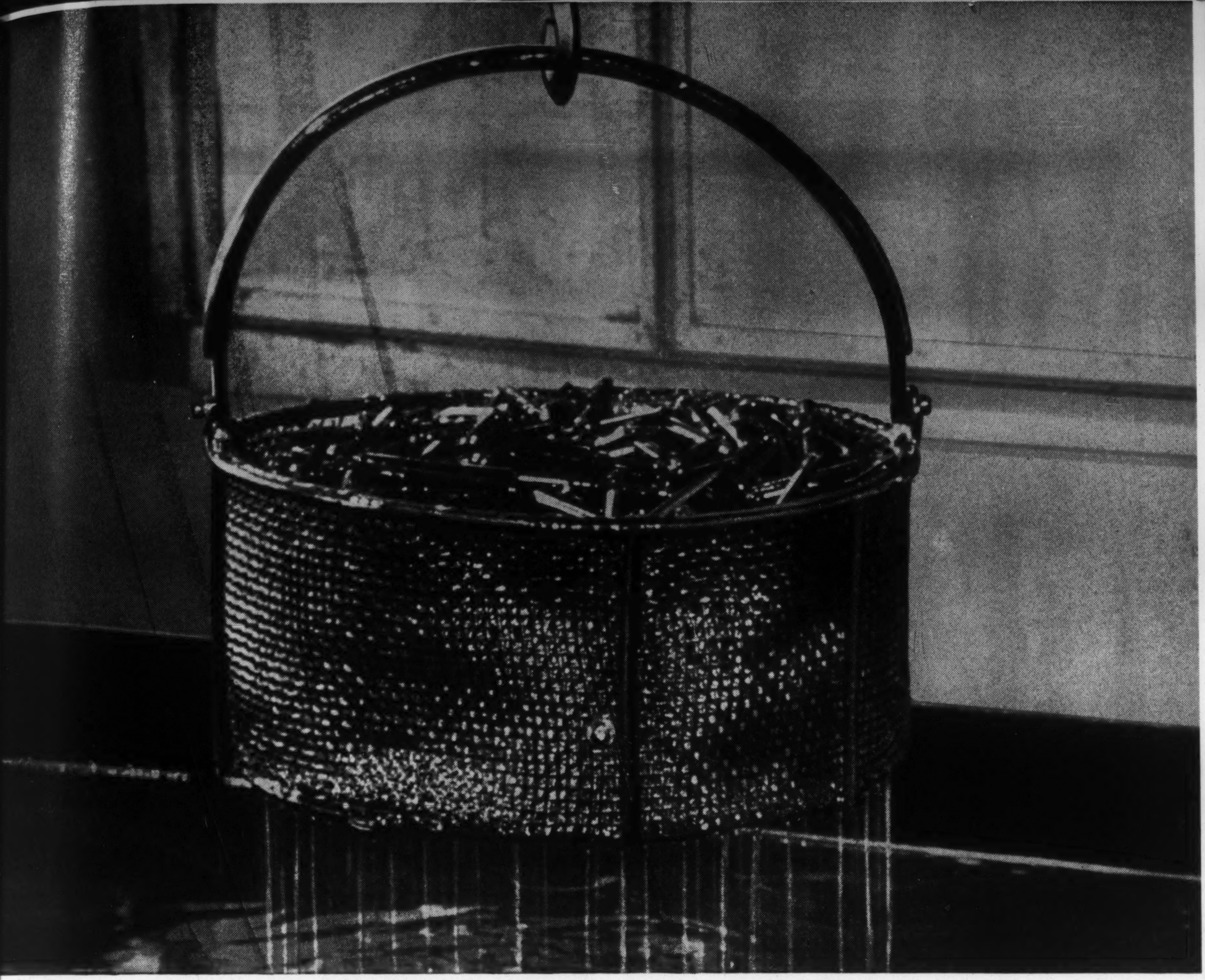
•

Hitchiner Manufacturing Co. has completed a plant expansion program which is expected to increase production capacity by 50%.

•

John B. Moore Corp. now occupies new offices at the Peerless Bldg., 384 Franklin Ave., Nutley, N. J. The company, however, will maintain its previous mailing address and telephone number.

(Continued on page 202)



You Get Minimum Drag-out with Sun Quenching Oil Light

When you reduce oil consumption by lowering drag-out, you cut a major cost in operating a quenching system. Sun Quenching Oil Light thins out when heated, drains off parts faster and more completely. And Sun Quenching Oil Light, because of its natural detergency, prevents the formation of sludge deposits, aids in removing any deposits that have accumulated. And under normal operating conditions it need never be replaced. Sun's booklet "Sun Quenching Oils" tells about this low-cost oil. For a copy, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. ML-12.

INDUSTRIAL PRODUCTS DEPARTMENT
SUN OIL COMPANY

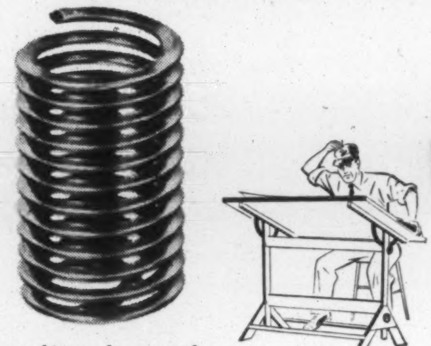
SUNOCO ®

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL
Made by the producers of famous Blue Sunoco Gasoline and Dynalube Motor Oils

For more information, turn to Reader Service Card, Circle No. 403

Instant Relief

FOR YOUR THREADACHES



The headaches caused by threaded fastenings — soft materials, corrosion, frequent use—are banished immediately with *Heli-Coil Screw Thread Inserts.**

Thousands of manufacturers have used and proved them. ***Heli-Coil*** Inserts provide much greater loading strength for your threads, make threads so perfect they will never wear, strip, seize, corrode, gall. With ***Heli-Coil*** Inserts you can use fewer, smaller, shorter fastenings and lighter, cheaper materials... this saves you space, weight and MONEY.

Check today on how and why ***Heli-Coil*** Screw Thread Inserts are the answer to the designer's prayer. Just mail the coupon for full information and samples.

***Heli-Coil* Inserts conform to official Military Standards MS-122076 (ASG) through MS-124850 (ASG) and others.**

* Reg. U. S. Pat. Off.

HELI-COIL CORPORATION
192 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send samples and Bulletin 689 — Military Standard Sheets.
☐ Please have a *Heli-Coil* Thread Engineer call.
☐ Send samples and Catalog.

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COMPANY__________
ADDRESS__________
CITY__________ ZONE_____ STATE__________ 2710

For more information, turn to Reader Service Card, Circle No. 354

news of | COMPANIES

Engineered Instruments, Inc. will take over the facilities and operations of D-V Welding Controls.

•

Bart Manufacturing Corp. has purchased the complete production facilities of Detroit Die Casting and Plating Co.

•

Alpha Corp. has moved to new and larger quarters at 65 Harvard Ave., Stamford, Conn.

•

Edgcomb Steel Corp. has changed its corporate name to Edgcomb Steel and Aluminum Corp.

•

E. I. du Pont de Nemours & Co., Inc. has opened its new plant for the manufacture of Mylar polyester film at Circleville, Ohio. The plant is already in commercial production.

•

Minnesota Mining & Manufacturing Co. will build a plant at Guin, Ala. for its Reflective Products Div. The plant will produce Scotchlite brand reflective sheeting and Centerlite brand stripping compound.

•

Firth-Loach Metals, Inc., newest entry in the rapidly-growing carbides field, has started operations in its new McKeesport, Pa., plant.

•

Lunn Laminates, Inc. has completed an expansion program at its plant in Huntington Station, N. Y.

•

Battelle Memorial Institute has announced plans for a $1,535,000 expansion of its nuclear-energy research facilities. The new facilities will be used for enlargement of the Institute's contract research for industry and government in the atomic-energy field. Construction of a nuclear reactor, a reactor development laboratory and a nuclear fuels laboratory is scheduled to begin shortly. Plans also call for the installation of a large cobalt-60 source.

•

Eutectic Welding Alloys Corp. has announced that the metal bonding adhesives formerly manufactured by the ChemoTec Div., will be manufactured, sold and serviced by the Adhesive Div., **Polymer Industries, Inc.**

•

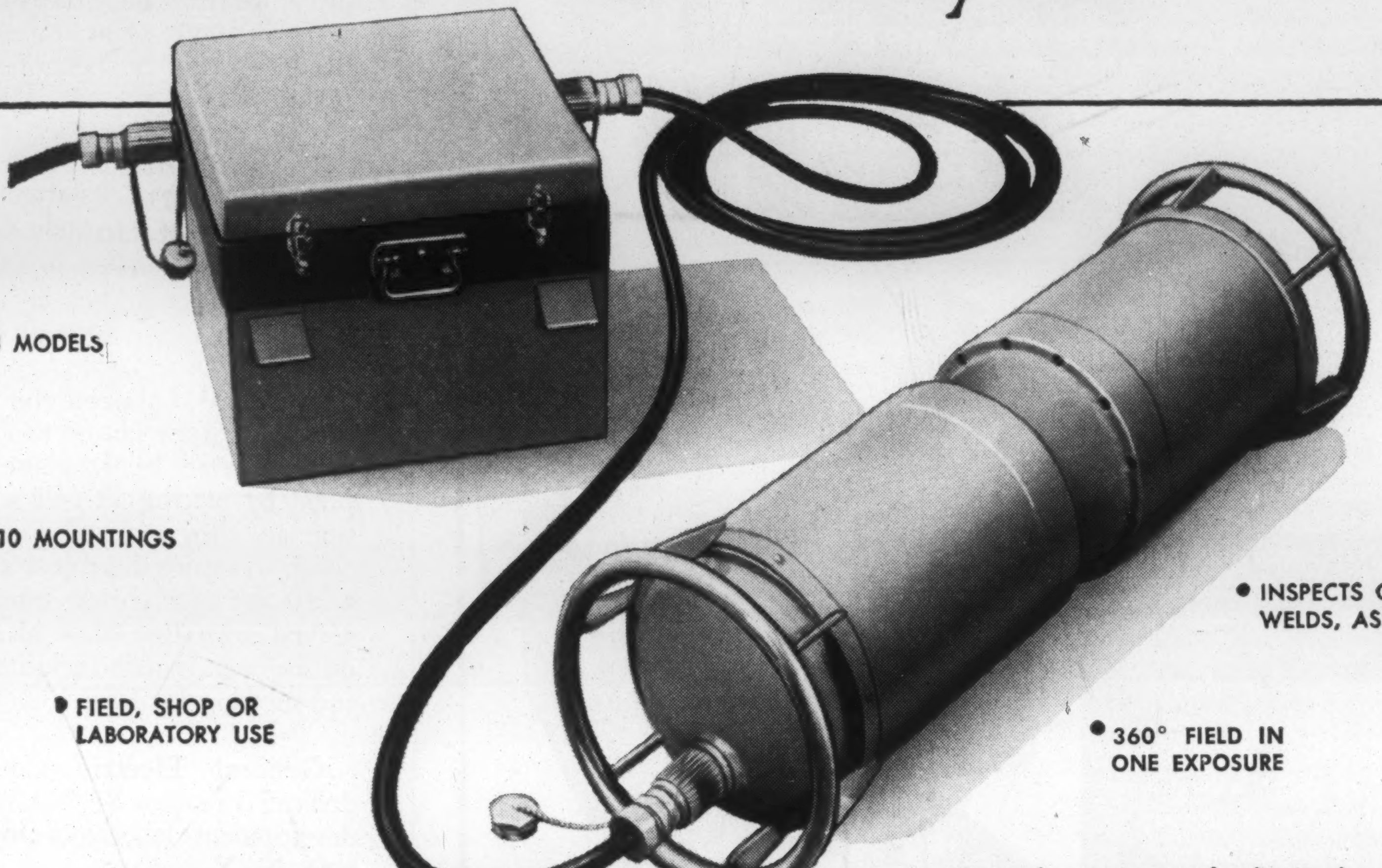
United States Graphite Co., Div. of Wickes Corp. has completed negotiations for the manufacture of Gramix sintered metal parts in Brazil.

(Continued on page 204)

General Electric Announces

OX-175

industry's newest, most versatile x-ray unit



- 3 MODELS
- 10 MOUNTINGS
- FIELD, SHOP OR LABORATORY USE
- FOR INSIDE-OUT RADIOGRAPHY
- FOR RADIOGRAPHY AND FLUOROSCOPY
- INSPECTS CASTINGS, WELDS, ASSEMBLIES
- 360° FIELD IN ONE EXPOSURE

Rugged, weatherproof tube head weighs only 185 pounds, has 10½-inch diameter (14-inch with handling rings). Control weighs 145 pounds, measures 18x18x14 inches.

It's dependable..it's portable..it's easy to use

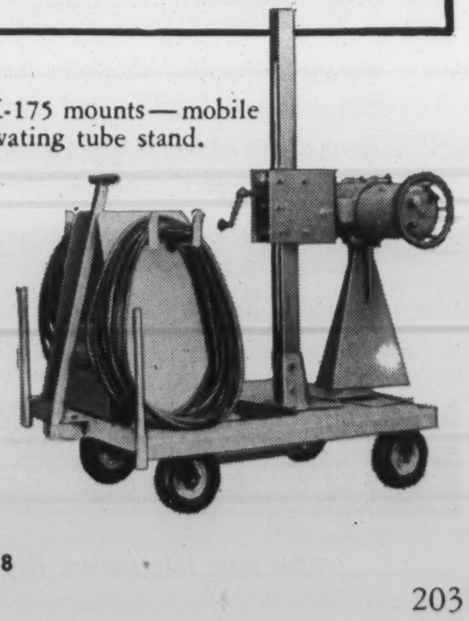
Here's the latest advance in industrial x-ray apparatus... designed and built for the widest range of functions ever handled by a single machine. It's General Electric's new OX-175 — a rugged, lightweight unit that will save time and cut costs in any plant that requires versatility in inspection procedures.

For example, the tube head's small size makes it ideal for inside-out radiography. Cable lengths up to 200 feet extend its portability. Equipped with a flat target tube, OX-175 produces a 360° field of radiation that will radiograph an entire circumferential weld in one exposure. Or by grouping castings or assemblies around the tube head, you can radiograph a large number simultaneously.

Check the list at right for the variety of mountings possible with the OX-175. Then call the G-E x-ray representative near you for complete information on this latest development in industrial x-ray. Or write X-Ray Department, General Electric Company, Milwaukee 1, Wis., for Pub. AZ124.

Look at the variety of mountings you can get

- MOBILE TRUCK
  - With elevating tube stand
  - Rotating tube stand
  - Tube carrier for 360° unit
- BRIDGE CRANE
  - 15—30-foot, with pantograph and motor-operated hoist.
- RADIOGRAPHIC CABINET
  - Automatic
  - Manual
- ELEVATING TUBE STAND
  - Mobile base
  - Fixed base
  - Rotating base



One of ten OX-175 mounts — mobile truck with elevating tube stand.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information, turn to Reader Service Card, Circle No. 338

Introducing—
THE MYCALEX PARTS KIT

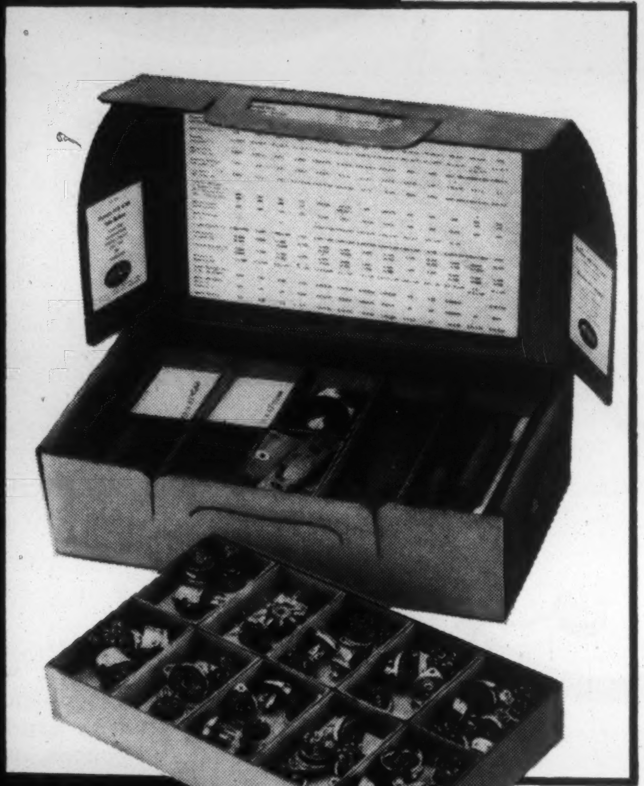
✳ For design projects

✳ For experimental use

✳ For emergency repairs

To acquaint engineers with the superior qualities of Mycalex glass-bonded mica — the world's most nearly perfect insulation — a conveniently packaged kit containing more than 30 Mycalex products has been assembled.

This assortment includes 46 miniature and sub-miniature tube sockets, terminal boards, rods and strips of fabricated Mycalex 400 and various Mycalex 410 injection-molded products such as connector sleeves, coil forms, stand-off terminals, rotors and rings, motor slot wedges and switch wafers. A handy reference table compares the superior physical and electrical properties of Mycalex glass-bonded mica with those of other insulating materials.



MYCALEX

- ✳ withstands extreme operating temperatures
- ✳ offers high arc resistances
- ✳ possesses low loss and power factors
- ✳ for permanent dimensional stability

The Introductory Mycalex Kit is being offered to qualified engineers and others who are interested.

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Clifton Boulevard, Clifton, New Jersey
Please send me the new Mycalex Parts Kit at the introductory price of $10.00.
Enclosed find Check......Cash......Money Order......
Name..Title....................
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City..................................Zone....State.....................

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THE INSULATOR
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New York 20, New York

MYCALEX CORPORATION OF AMERICA
World's largest manufacturer of glass-bonded mica products

For more information, turn to Reader Service Card, Circle No. 323

news of | COMPANIES

Brassinter, S. A., Sao Paulo, will manufacture both rough and finished sintered metal parts bearing the trade name Gramix under exclusive contract with United States Graphite Co.

•

National Starch Products, Inc. has purchased a tract of land at Meredosia, Ill. for the construction of a second vinyl plant to supplement production of its Plainfield, N. J. plant.

•

National Aniline Div., **Allied Chemical & Dye Corp.,** has started construction of facilities for production of diisocyanates in introductory commercial quantities at its Buffalo plant.

•

Austenal Laboratories has completed a tenth addition to its facilities at the Dover, N. J., plant Microcast plant by placing in full scale operation an alloy making unit. The recently completed project consists of a 10,000-sq-ft brick building furnished with the latest in alloy producing equipment including casting and shotting facilities.

•

General Electric Co. recently dedicated its new $3,500,000 turbine development laboratory in Schenectady, N. Y.

•

Kaiser Aluminum & Chemical Corp. has announced the acquisition of a forging plant at Erie, Pa., for the production of aluminum die forgings.

•

Dow Chemical Co. has announced the formation of a research development section in its Market Research Dept. The group's primary responsibility will be to analyze specific industrial fields as a means of forecasting long-range trends and needs of various industries.

•

Ford Motor Co. recently opened its newest and most modern V8 engine plant at Dearborn, Mich. The new plant is operated by Ford's Engine and Foundry Div. and contains 1,500,000 sq ft of floor space equipped with the latest developments in automation devices and machine tools.

•

Tincher Products Co. has moved its headquarters to 2023 South 60th St., Milwaukee, from Sycamore, Ill.

•

General Electric Co.'s Power Transformer Dept. recently dedicated

This female has good connections
in air conditioning

IT'S MADE OF "BERYLCO" BERYLLIUM COPPER

Intermittent air conditioning, railroads find, is worse than none. They solve that problem by connecting conditioned cars to stand-by power when the train is not running. The chances are that the connectors used will be those made by Joy Manufacturing Co., which feature replaceable female contacts made of "Berylco" beryllium copper.

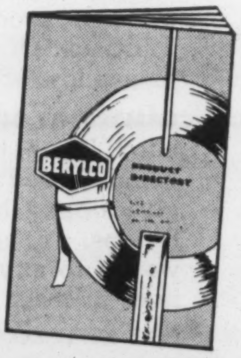
Electrical conductivity, of course, is a must in any contact, but even more important here is the elasticity and wear resistance required. For this combination of qualities, "Berylco" can't be beat. It will take repeated abuse without appreciable wear. It has plenty of "bounce" to resist taking a permanent set or to relax after many, many rough connect and disconnect operations. It doesn't lose its bulldog grip under the jockeying railroad cars are subject to.

If you are looking for an engineering material which will do more than one job well, you ought to investigate the advantages of "Berylco" beryllium copper. No other alloy combines such properties as strength, hardness, conductivity, fatigue resistance, corrosion resistance, elasticity and formability.

For engineering help or sample material, write any of the offices listed below.

ALL THE FACTS

This 20-page booklet lists available beryllium copper forms and materials, offers you the most complete selection in the industry. Send for your free copy today.



TOMORROW'S PRODUCTS ARE PLANNED TODAY . . . WITH "BERYLCO" BERYLLIUM COPPER

BERYLCO THE **BERYLLIUM** CORPORATION

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Representatives in principal world-trade centers

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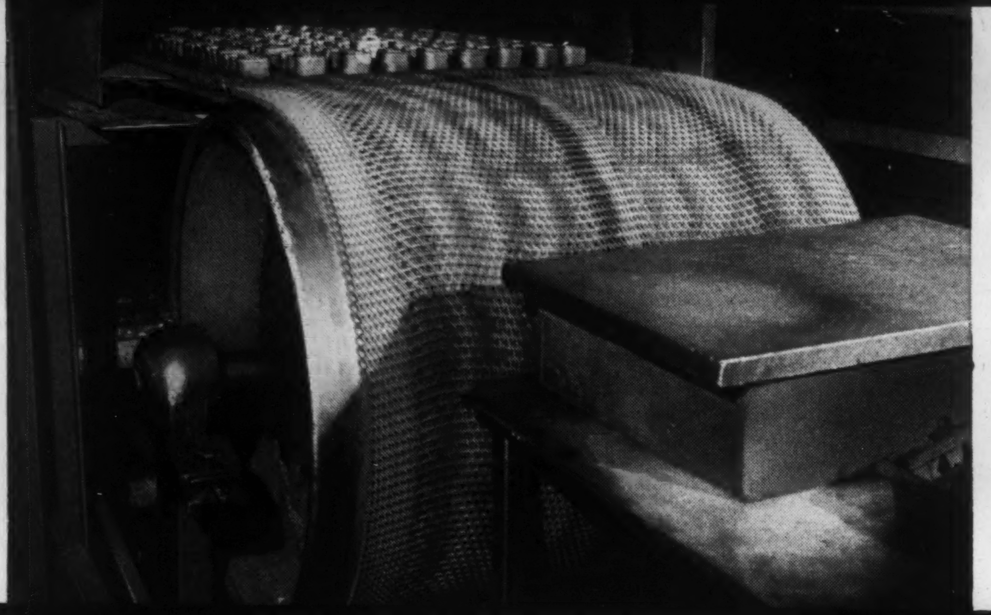
idea for AUTOMATION

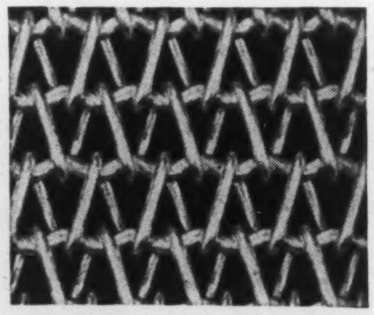


with CAMBRIDGE
Woven Wire Conveyor Belts

CONTINUOUS BRAZING

Metal products can be heat treated, quenched and cooled in one continuous series of operations on Cambridge belts. All-metal belt is unharmed by temperature, quench oils or sharp-edged, heavy loads.

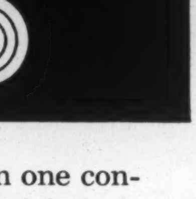
If you're still heat-treating by costly, time-wasting batch operations you'll find Cambridge Woven Wire Conveyor Belts help provide cost-cutting, automatic production by allowing you to process the work *continuously*. No batch operations, less manual handling for such processes as: annealing, tempering, brazing, sintering, soldering, as well as quenching, pickling, oiling, washing.



OPEN MESH CONSTRUCTION of the belt provides free circulation of heat-treating atmospheres for uniform processing, free drainage of process solutions. Of course, the all-metal construction means lowest maintenance cost.

CAMBRIDGE BELTS are available in any metal or alloy. Thus, the belt recommended for you can be fabricated from the specific material that will give longest belt life under your operating conditions. In addition, Cambridge belts can be woven to any length or width and in a wide variety of weaves and mesh sizes to meet your needs.

FREE REFERENCE MANUAL gives full details on how Cambridge belts can boost output, cut costs by providing continuous, automatic production . . . *automation!* Includes all specifications and details, also metallurgical tables. Write for your copy today! Or, for specific recommendations, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified 'phone book.



The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department A
Cambridge 12, Maryland

OFFICES IN LEADING INDUSTRIAL AREAS

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news of | COMPANIES

its new $1,500,000 sound laboratory with the world's largest anechoic chamber at Pittsfield, Mass.

•

International Business Machines Corp. has opened its new research laboratory at Poughkeepsie, N. Y. Nearly 600 engineers and researchers will work in the building on basic materials research and component development and testing.

•

Pressed Steel Car Co., Inc. has announced the purchase of **Clearing Machine Corp.**

•

Koppers Co., Inc. will sponsor a design competition for plastics molders.

•

H&H Tube and Manufacturing Co. has announced that its services now include the cold fabrication of welded and seamless steel and aluminum tubing.

•

Efficient Tool & Die Co. has announced the construction of a second plant in Cleveland to be located on Old Brecksville Rd. Housed in the new building will be the company's Die and Keller Model Dept., Engineering Dept. and die tryout facilities for large sheet metal dies.

news of | SOCIETIES

The **James F. Lincoln Arc Welding Foundation's** First Grand Award in a national design competition was received by Richard Seikaly of Syracuse, N. Y. The award, which was accompanied by a check for $1250, was made for a paper presenting a comparison study of a band saw frame to demonstrate the advantage of welded design over cast iron design. The Foundation also presented Syracuse University, where Seikaly made the study, $1000 for four annual scholarships honoring Mr. Seikaly.

•

The **Society of Industrial Designers** recently elected Peter Muller-Munk, Peter Muller-Munk Associates, as its president. Arthur N. BecVar, General Electric Co., Louisville, was elected executive vice president.

•

The **Electrochemical Society** has elected Dr. Thomas P. May, technical manager of International Nickel Co.'s Kure Beach Corrosion Testing Station, as vice chairman of its Corrosion

See what adhesives are doing today!

Sealing trailers at the seams

3M
COMPANY

When you consider the amount of weathering to which a house trailer is exposed in the course of its service, you can appreciate the importance of effective, all-around sealing.

Finding a seal to keep out dust, weather and noise used to present a real problem. But it doesn't any longer—thanks to 3M's new ribbon-like sealer, EC-1202. Made of synthetic rubber, EC-1202 is extremely flexible and easy to handle. And it's reinforced with sturdy fabric so that it holds its dimensions and is exceptionally easy to apply.

On trailers, like the one pictured above, EC-1202 is used to seal metal corners and edges. Next, an extruded aluminum corner is bolted over it for extra protection, to provide a complete seal against weathering of all sorts.

See what adhesives can do for you . . . You can use EC-1202 wherever metal corners, edges, or faying surfaces need sealing. Your 3M sales engineer will give you all the facts on this and other 3M adhesives developed for industry. Call him, or write today for free informative booklet—to 3M, Dept. 612, 417 Piquette Ave., Detroit 2, Mich.

see our catalog in
PRODUCT
DESIGN
FILE
or write for copy

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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SEND FOR SAMPLES
of
Sinko NYLON MOLDINGS

You'll find this Tough, Lightweight, Resilient material admirably suited for fabricating many of your parts.

Sinko NYLON possesses many properties proven highly desirable especially for those small, intricate components that are subjected to extremes in shock and wear. Sinko NYLON is also self-lubricating; quiet in operation; an excellent electrical insulator; and resists heat, shock, wear and abrasion.

Be sure to check with us on the advisability of using this exceptional material in the production of your products and parts.

The following represent just a few of the many and varied items that are now *being made better* with Sinko NYLON:

√ Gears, Insulators
√ Rivets, Screws
√ Rollers, Valve Seats
√ Bearings, Washers
√ Coil Forms
√ Connectors
√ Wearing Surfaces of All Types

SINKO molds all Thermoplastic Materials, including the remarkable new KEL-F . . . in sizes from 4 to 60 oz. A highly skilled staff of specialists, using the latest in modern equipment, will manufacture your injection molded parts and products with the utmost in accuracy, speed, and economy.

Our services include Design and Engineering; Mold Construction; Metal-Plastic Assemblies; 2 and 3 color plastic Spraying and Painting; Hot Stamping; Vacuum Distillation Plating; Fabricating and Assembling.

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Div. At its annual convention recently held in Boston, the Society presented George W. Heise, recently retired associate director of the Research Laboratories, National Carbon Co., with its Acheson Medal and Award. This award, consisting of a gold medal and a cash prize of $1000, was established in 1929 and is the Society's highest award.

•

The **American Welding Society** will award $700 in prizes for the two best articles on welding to appear in undergraduate publications during the current school year. These awards are made annually by the Society under the A. F. Davis Undergraduate Welding Award Program.

•

Pennsylvania State University has announced that Proceedings are now available on short courses held at the University during June, 1954, dealing with high temperature properties of materials and mechanics of creep.

•

The **Society for Nondestructive Testing** and the **X-Ray Dept., General Electric Co.** jointly presented the 2nd Annual Coolidge Award to Norman C. Miller and John D. Steely, staff members of Los Alamos Scientific Laboratory, for their article, "Some Experimental Findings and Operating Practices in Betatron Radiography".

•

The **Instrument Society of America,** at its recent annual council meeting, elected the following officers: Warren H. Brand, director of engineering and research, Conoflow Corp., president; A. A. Anderson and W. H. Fortney, vice presidents.

•

Foundry Equipment Manufacturers Association, Inc. elected the following national officers at its annual meeting: William B. Wallis, president, Pittsburgh Lectromelt Furnace Corp., president; David E. Davidson, vice president - sales, Link-Belt Co., vice president.

•

The **American Zinc Institute** is making available to industry and educational organizations a new 16-mm color and sound motion picture which shows how to improve product design and reduce costs through die casting. The film is entitled "Die-Casting — How Else Would You Make It?".

New Jobs for One of the World's Most Useful Metals:
STRAITS TIN from MALAYA

Concentrating tin ore in Selangor, Malaya. Malayan economy depends heavily on tin exports. Thus a continuing and stable market for tin is as vital to Malaya as a continuing and stable supply is to the United States.

New Tin Alloys---New Techniques Make Soldering Faster, More Efficient

They've been using tin-rich solders for almost 2000 years — and haven't found a real substitute yet! Nothing else is as cheap or easy to use in making corrosion-resistant, impermeable, electrically conductive joints at relatively low temperatures.

Making Solder Still More Efficient

Now, new alloys and new soldering techniques are making tin solders still more useful on production lines.

A solder of tin-indium, for example, is now used for sealing glass to metal or glass to glass—will adhere to mica, quartz, thermosetting plastics, and some glazed ceramics, as well.

For joining aluminum, cerium added to a tin-rich, tin-zinc solder gives both improved salt spray resistance and better wettability.

New techniques for applying solder include ultrasonic methods of soldering and tinning aluminum, and the new mechanized dip soldering process that is saving industry thousands of man-hours.

Tin is, of course, the key ingredient in solder. Over one-third of the world's tin is mined and smelted in Malaya. Known as Straits Tin, this metal is more than 99.87% pure and is world-famous for its absolute reliability of grade.

A New Look at Straits Tin

Today, not only new solders but new tin alloys, new tin-alloy coatings and platings, and new uses for tin chemicals have been discovered that make Straits Tin more valuable than ever to American industry. And continuing research will find still more ways in which tin can serve you in the near future.

Whatever your product or process may be, now is the time to reappraise carefully the unique combination of properties of Straits Tin. For no other metal we know today can do so many different kinds of jobs so economically and so well.

MALAYAN
TIN
BUREAU

A new booklet, "Straits Tin: A Most Useful Metal for American Industry," tells a factual and intriguing story of the many new ways tin can be used today. A copy is yours for the asking.

STRAITS TIN
A MOST USEFUL METAL FOR AMERICAN INDUSTRY

THE MALAYAN TIN BUREAU
Dept. 690, 1028 Connecticut Ave., Washington 6, D.C.

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when your
customers
ask about . . .

product strength—

Cite the facts on the extra strength you have built into your product by designing with Hackney Deep Drawn Parts. Point out that a deep drawn shape or shell is often stronger than a cast, forged or welded pipe part which it replaces, even though it weighs far less.

That's the way hundreds of other manufacturers have designed stronger and more durable products. They discovered that Hackney Deep Drawn Parts can be made from high strength steel—can be heat-treated to minimize welding and forming stresses — can meet some design requirements as a one-piece, entirely seamless part.

In addition to extra strength and extra long life, Hackney Deep Drawn Shapes and Shells often contribute other product improvements, including:

Closer tolerances
Vibration resistance
Streamlined appearance
Faster assembly—Lower cost
Sizes from one quart to 150 gallons
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136 Wallace Ave., Downingtown, Pennsylvania

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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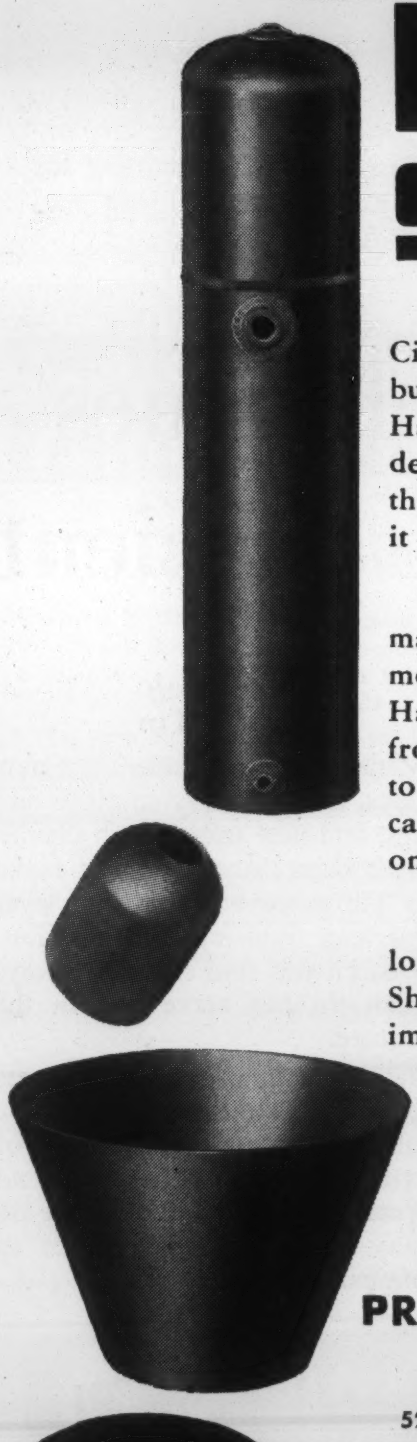


Plastic Plane . . .

continued from page 13

fabric and much less costly than replacing or repairing aluminum sections. The large size of the plastic skin sections eliminates many skin joints and significantly reduces parasite drag. The plastic skinned models, which utilize the basic Taylorcraft design, enjoy a 12-mph speed advantage over their sister ships of stressed aluminum and fabric.

Design Freedom

Since it is as simple to mold irregular curves as to mold straight sections in reinforced plastic, several structural changes in the new Taylorcraft have taken advantage of this design factor. Gas tanks are molded to fit irregular spaces, giving a five gallon increase in fuel capacity, and the passenger cabin has been bulged slightly to provide increased shoulder space without sacrificing aerodynamic conformity with the rest of the fuselage. Mr. Mauro said that while the material cost of reinforced plastic is high, it is more than offset by a tremendous saving in labor, tooling and prototype construction costs.

Construction Details

The Taylorcraft fuselage section is molded in two halves, which are fastened to longerons and other fuselage members by a bolt and strap technique. Small ridges, or bulkheads, are integrally molded on the inside of the fuselage skin, and it is to these that the structure is attached, thus avoiding any external rivets, bolts or other drag-producing irregularities.

The wing skin is fastened to ribs and spars by blind rivets, in much the same way as stressed aluminum. Mr. Mauro said his company was investigating several techniques to eliminate the external fasteners, but did not elaborate.

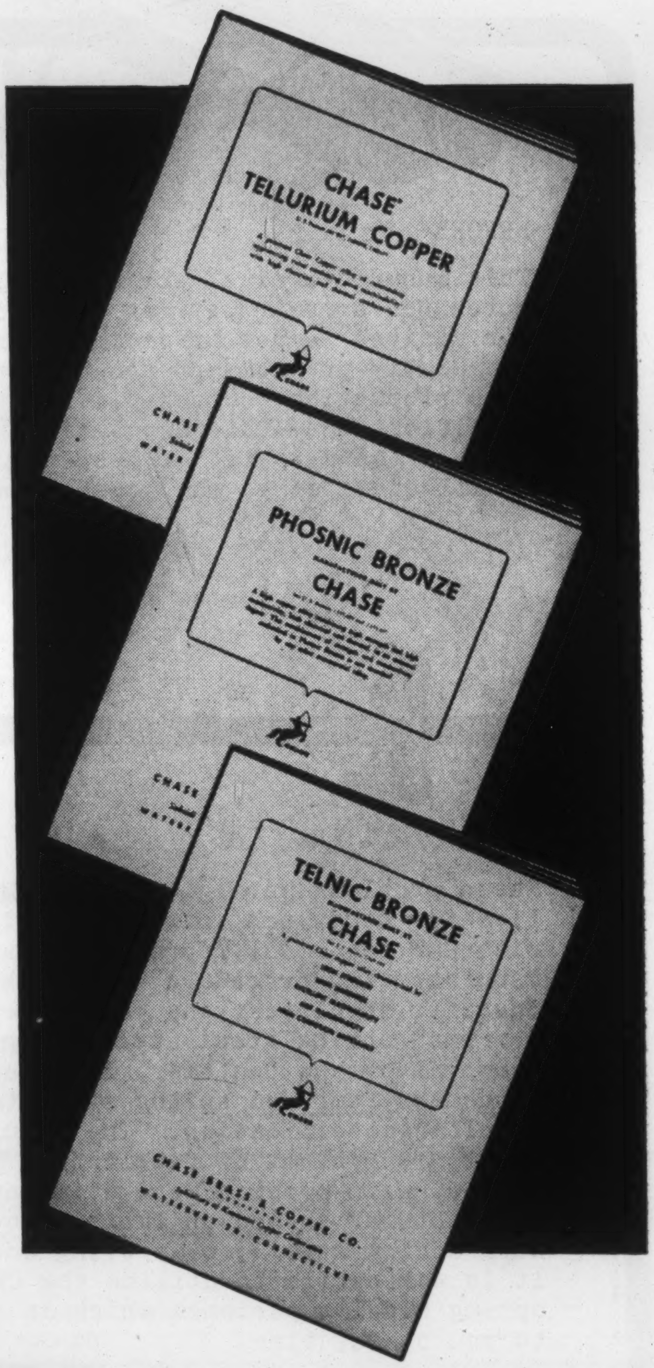
The plastic skin is highly resistant to weathering and corrosion, two very important factors for consideration if the plane is to used for spraying and crop dusting or if it will be unhangared for considerable periods.

Production and Cost

Three fiber glass skinned models are now in production at Taylorcraft, and although none have been certified, the company has been working in close cooperation with the CAA and expects no certification

SPECIAL JOB?

Get a special Chase alloy!



TELLURIUM COPPER

This alloy, developed by Chase, has excellent machinability *plus* high conductivity. Chase Tellurium Copper can be machined with tool speeds and settings similar to those used with Free-Cutting Brass, permitting high rates of production. But, unlike Free-Cutting Brass, Chase Tellurium Copper may be hot worked easily, and may be cold worked almost as extensively as pure copper. For Chase's free Tellurium Copper booklet, check the coupon below.

PHOSNIC® BRONZE

Chase Phosnic Bronze, an alloy made *only* by Chase, combines high strength and high conductivity to an amazing degree. This combination of high strength, high conductivity is *not matched by any other commercial alloy*. Chase Phosnic Bronze also has excellent workability, high corrosion resistance, and is available in tube, rod, and round or rolled flat wire. For Chase's free Phosnic Bronze booklet, check the coupon below.

TELNIC® BRONZE

By adding small, accurately proportioned amounts of tellurium, nickel and phosphorus to copper, Chase developed Telnic Bronze—a truly "all purpose" alloy. Chase Telnic Bronze has *excellent* machinability, hot and cold workability, high strength and conductivity, high fatigue strength and superior corrosion resistance. Chase Telnic Bronze is available in round or hexagonal rod. For Chase's free Telnic Bronze booklet, check the coupon below.

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a CMP cost cutting report
ON THIS SPRING STEEL PART
CMP COLD ROLLED TEMPERED
SPRING STEEL
made it easier
at less cost

BEFORE

This manufacturer of spring steel parts purchased annealed spring steel and processed it for desired temper preceding fabrication. Frequently problems of non-uniformity slowed down production. Often-times parts did not meet specifications--tolerances were too variable--fatigue tests would not meet requirements. It all added up to many costly rejects.

AFTER

These problems were given to a CMP representative for study and, after several discussions with CMP technical representatives, a new manufacturing procedure was established. Specific specifications were developed by CMP for each spring steel application and, after approval by the Customer, CMP then produced and processed tempered spring steel to each such specific specification. The manufacturer's previous problems of fabrication and tempering-in-process were eliminated and the manufacturer showed an improved cost on each such spring steel job, proving once again that it is worthwhile to utilize the CMP technical spring steel experience which is available to you at any time.

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News Digest

Sandwich construction of skin, ribs and spar is revealed in cut away section of plastic wing.

Air Force Photo

problems to arise. Of the 3 models, the most expensive is a 225-hp version in the $9000 range. A lower priced four placer with 145 hp will sell for around $6000. In a crop dusting configuration, the 225-hp model will lift approximately its own weight, 1450 lb., in payload. Initial plans call for one plane a day production, but the flexibility of the plastic molding process will permit expansion to four or five per day if sales warrant.

Background

While the plastic skinned Taylorcraft uses a greater proportion of plastic than any other commercial plane, glass-fiber reinforced polyester components are to be found in many aircraft. Hiller makes a small helicopter with an all-molded fuselage, and Bell is producing glass fiber reinforced doors and fuselage panels for its two and three place helicopters.

The U. S. Air Force has been investigating the use of reinforced plastic for structural use in lightly loaded aircraft since 1936. A program was started during the war to build all plastic wings for the AT-6 trainers, but the project was never under much pressure for completion, and after the war, lack of funds almost caused its cancellation before a flying version could be produced. Only two wings were built, and the first was tested to destruction. The second wing, completed last year, is all plastic, including spars and ribs, and has undergone more than 800 hr of flight testing. It is slightly heavier than a conventional wing, but tests reveal that its strength is far in excess of requirements. The elimination of parasite drag on the wing increased the AT-6 cruising speed about 5 knots.

(More News Digest on page 214)

How G.E.'s silicone rubber coating compound SE-100 enables Con Edison cable to carry

NEARLY TWICE THE CURRENT WITH NO INCREASE IN SIZE

When Consolidated Edison came to the Wire and Cable Department of General Electric for generator leads with greater capacity, a tough cable problem came along, too. Con Edison needed cable to carry *increased loads without increase in size.*

By taking advantage of the new SE-100 silicone rubber coating compound developed by the G-E Silicone Products Department, G-E wire engineers were able to build a cable that could carry *nearly twice as much current as before with the same conductor cross section!*

silicones
for industry
General Electric

HOW CAN SE-100 BENEFIT YOU?

General Electric's new SE-100 offers a combination of heat life, electrical properties, and abrasion resistance superior to any other silicone rubber coating material. SE-100 is ideal for coating glass or organic fabrics for service at high or low temperatures, or where resistance to weather, ozone, corona, or chemicals is required. Where can *you* use it to extend equipment life, minimize insulation failures or create new product designs?

Ask your fabricator to tell you more about SE-100, or send the coupon *today* for complete information!

G-E silicones fit in your future

GENERAL ELECTRIC

CLIP AND MAIL TODAY!

General Electric Company
Section 463-3B
Waterford, New York

Please send me product data on SE-100, list of fabricators, and a copy of *G-E Silicones for Industry.*

Name____________________

Position____________________

Firm____________________

Street____________________

City__________ Zone____ State______

IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto

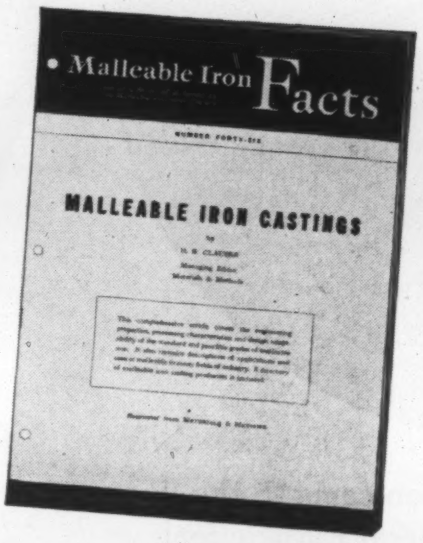
For more information, turn to Reader Service Card, Circle No. 451

...How about Malleable?

Versatile Castability Permits Wide Freedom of Design

The ability of malleable iron to be cast into intricate shapes and close to final form provides the design engineer with an extremely useful ferrous material. Complicated and expensive assemblies can often be combined into one easily machined, tough casting. Drilling and boring operations are often eliminated for further savings.

Whether you are designing new products or reviewing present production keep malleable in mind. Call a malleable foundry and go over your products with their engineers. They can give you information and suggestions that help you design better products that can be made at lower cost.



Malleable Iron Facts

MALLEABLE IRON CASTINGS

Free Design and Application Data to Help You Design with Malleable

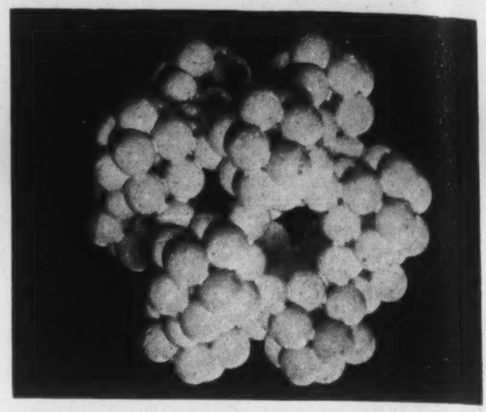
This issue of Malleable Iron Facts contains valuable data on grades, design and application of malleable iron to aid the design engineer.

Ask your malleable castings supplier for copies or write to the Malleable Founders' Society

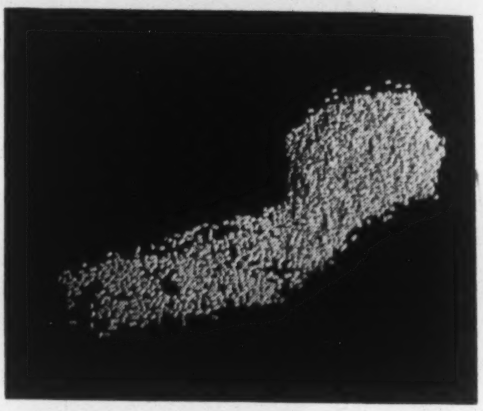
Malleable
FOUNDERS' SOCIETY

1800 Union Commerce Building
Cleveland 14, Ohio

For more information, turn to Reader Service Card, Circle No. 402



Model of the crystal structure of synthetic zeolite reveals holes surrounding hollow core.



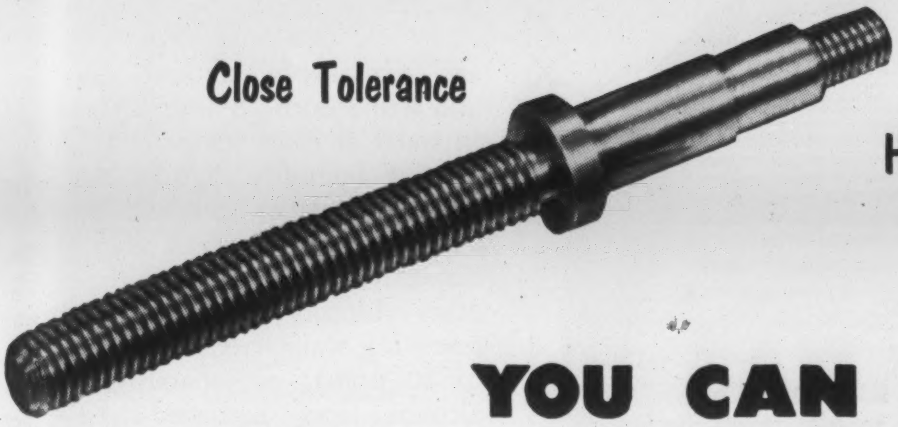
Molecular sieve material is extruded in 1/16- and 1/8-in. diameter pellets.

New Adsorbent Sorts Molecules

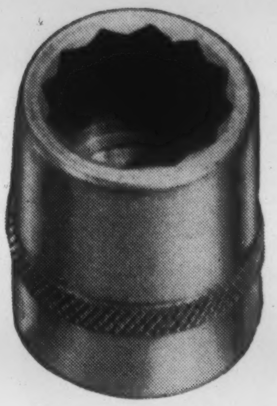
A synthetic material which can screen gases or liquids according to differences in molecular size or molecular bond arrangement was announced recently by Linde Air Products Co. Dubbed "Molecular Sieves", the remarkably selective synthetic zeolite represents a major step in furthering the application of adsorption in industrial processing.

The molecular sieves can perform separations ordinarily requiring a series of fractional distillations, and in some instances can separate materials almost impossible to sort by other methods. The synthetic adsorbents are relatively inexpensive, have excellent chemical and heat stability, and are easily regenerated.

The basic action of the sieves involves the capacity to adsorb molecules having a minimum dimension below a given size, while passing all molecules having a minimum dimension above that size. The sieves

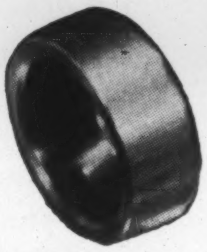


Close Tolerance

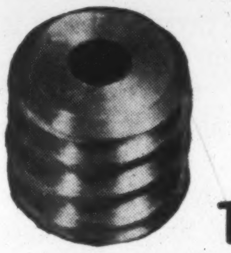


High Strength

YOU CAN HAVE ALL SIX
... PLUS *Uniform Machinability*



Fine Surface



Toughness

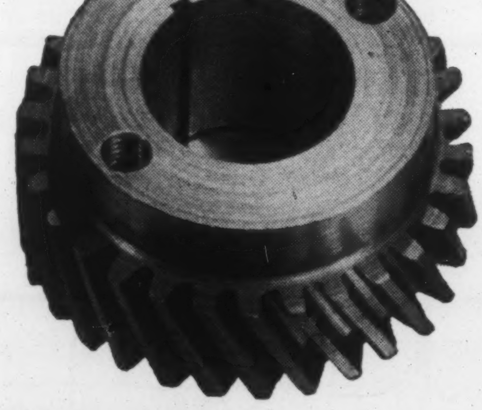
Maybe you want some of these properties in your steel parts. Or a combination of them. Or only one.

No matter which ones you need, you get them—plus *uniform machinability*—in Republic Cold Drawn Steels.

That's why so many manufacturers have come to Republic with their machining problems. Manufacturers whose costs and production records show their automatics aren't turning out what they could.

Republic's 3-D Metallurgical Service focuses the combined experience of the Field, Mill and Laboratory on your particular problem. And the recommendation you get is based on your plant, your product, and your equipment.

There's no reason to deny yourself this service. It costs only the price of a phone call to your nearest Republic office. And it can save you a lot. Do it today.



Hardenability

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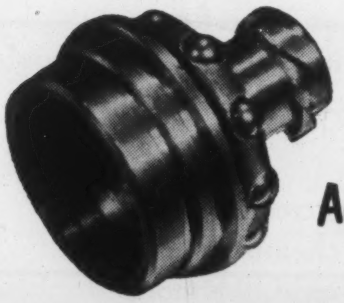
Union Drawn Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York



Accuracy of Section

REPUBLIC COLD DRAWN ALLOY STEEL BARS

REPUBLIC STEEL

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Bars, Wire, Pig Iron, Steel and Plastic Pipe, Bolts and Nuts, Tubing

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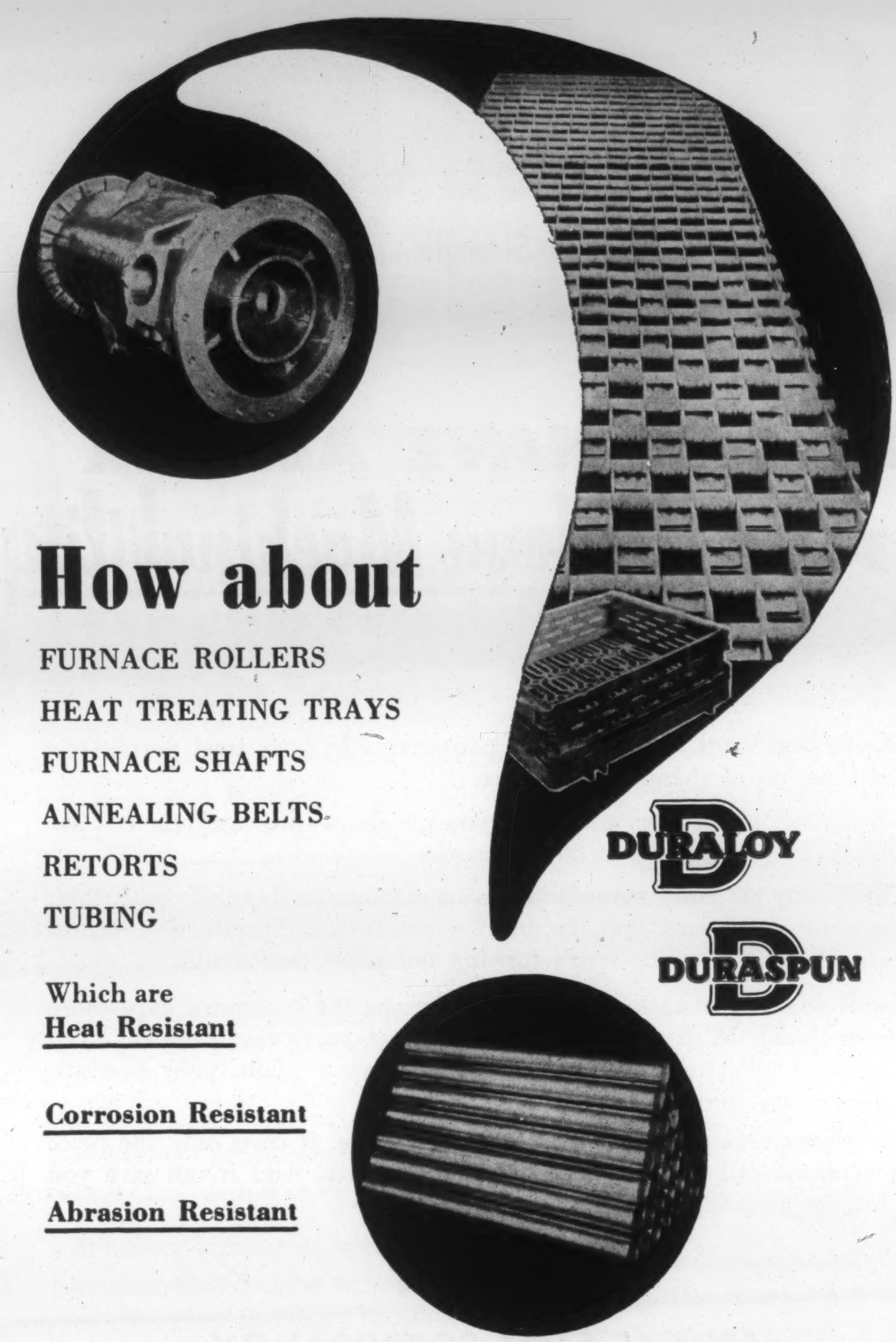

How about

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HEAT TREATING TRAYS
FURNACE SHAFTS
ANNEALING BELTS
RETORTS
TUBING

Which are
Heat Resistant

Corrosion Resistant

Abrasion Resistant

When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.

Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma-ray technicians. If you would like more preliminary information, send for Bulletin No. 3150-G.

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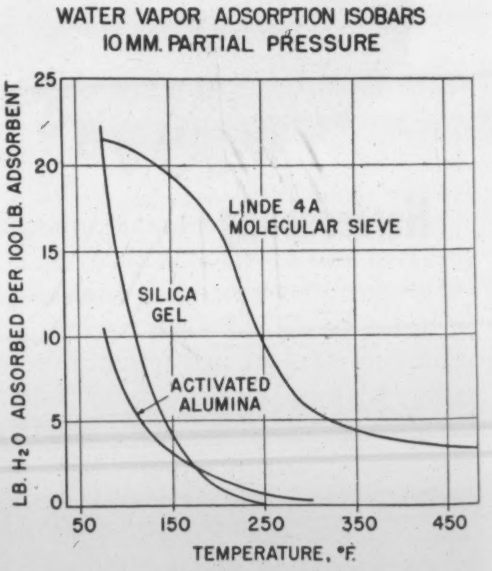
News Digest

are remarkably efficient dessicants and will adsorb 18% of their weight in water at room temperature at 1% relative humidity. Under the same conditions, silica gel and activated alumina will adsorb 3 and 3½%, respectively. The sieves will perform other difficult separations, such as removing water from ethanol (down to 10 ppm), or separating n-butyl alcohol from branched-chain, isomeric butyl alcohols of larger molecular diameter.

How They Work

The unusual selectivity, capacity and stability of molecular sieves is due to their unique crystal structure. Molecular sieves are synthetic zeolites composed of soda, lime, alumina and silica, plus water of hydration. Unlike most hydrated materials, when the water is driven off, the crystal does not lose its structure. Rather, it retains its original dimensions and configuration and a network of pores and cavities forms in place of the water of hydration. Roughly speaking, the dehydrated crystals resemble ping pong balls with holes drilled in them. The size of the holes determines the adsorptive characteristic of the sieve, since molecules small enough to pass through the holes in the crystal become enmeshed in the intramolecular fields inside the crystal and are held there, much as a magnet inside a ping pong ball would hold steel shot small enough to fit through holes in the cover of the ball. Larger molecules, which cannot get



Desiccant efficiency of molecular sieve is revealed in comparison to performance of silica gel and activated alumina.

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Harshaw Perglow Bright Nickel . . . proved with more than 227,000,000 ampere hours of successful operation.

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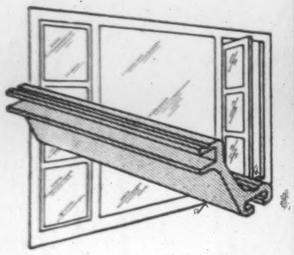

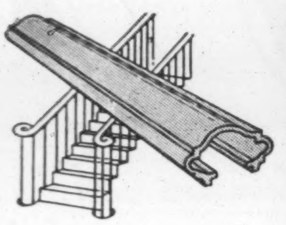

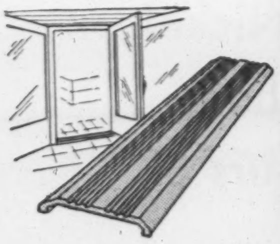

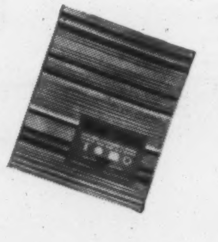

HOW PE "CREATIVE EXTRUSIONEERING" CAN HELP YOU CUT MANUFACTURING COSTS ... IMPROVE PRODUCT QUALITY

PE's Creative "Extrusioneering" is more than just a designing and mill service. It's an expanded assistance program designed to help you create new aluminum extrusion applications for your product . . . applications that will cut manufacturing costs and improve product quality. Because PE's staff of competent engineers have wide experience in all types of fabricating operations, they can provide invaluable aid in helping develop ideas that will, for example, reduce fabricating costs, simplify assembly, eliminate machining operations, and provide greater stability and strength. Why not call in a PE engineer without obligation and let him analyze your product for possible cost-cutting extrusion applications. PE aluminum extrusions are produced under the latest methods of scientific quality control . . . facilities are complete from billet casting to finished extrusion. PE specializes in the job of PRODUCING EXTRUSIONS ONLY . . . they do not fabricate, they do not manufacture any other product. Your inquiries receive personalized and confidential attention.

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News Digest

to the strong fields inside the crystal, are not adsorbed.

Molecular sieves will adsorb both water and hydrocarbons. Unlike other adsorbents, they do not necessarily select the higher boiling component of a mixture in preference to the lower boiling one.

Two types of sieves are now available; one, type 4A, has a pore opening of 4 angstrom units (about 16 billionths of an inch) and adsorbs only those molecules with a critical diameter less than that pore size. The other, designated type 5A, has a pore diameter of 5 angstroms. As an example of operational possibilities, type 4A will adsorb ethane but not propane. Type 5A will adsorb straight chain hydrocarbons such as n-hexane, but not branched chain isohexanes nor cyclic hydrocarbons such as cyclohexane and benzene.

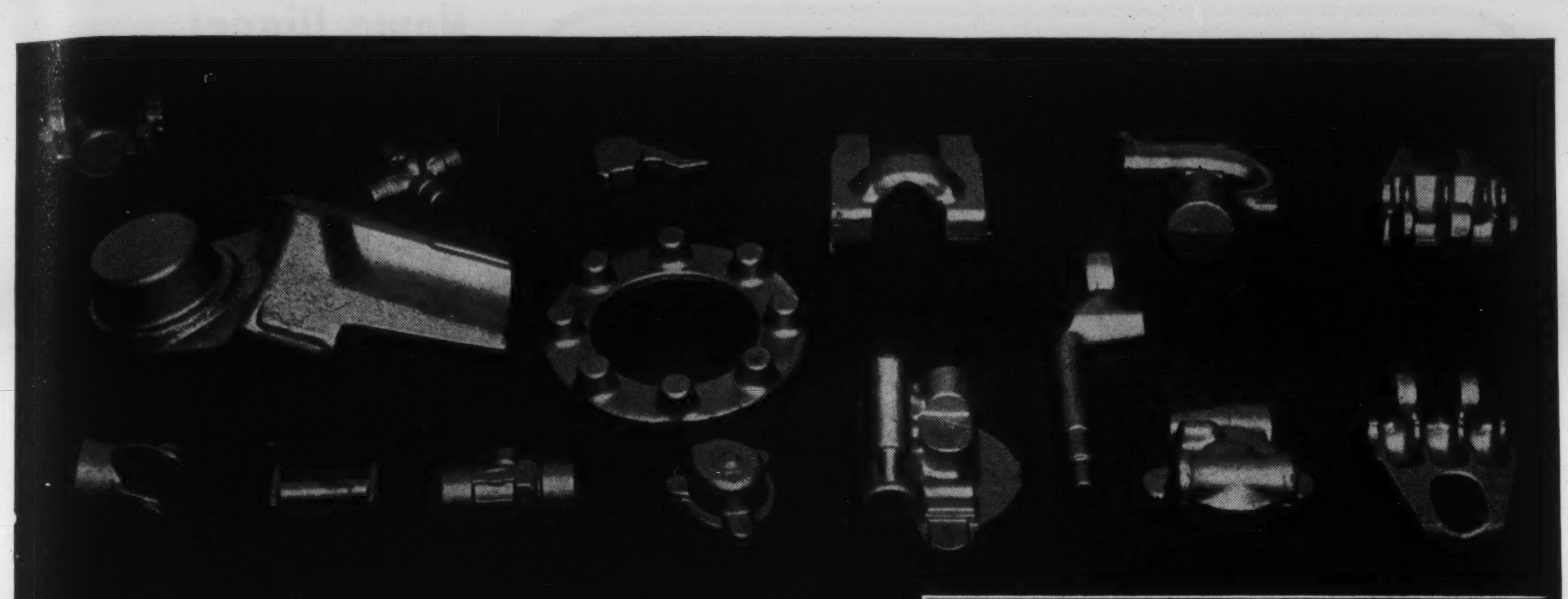
Saturated molecular sieves are regenerated by passing hot gas or air through the filtration bed. If unstable compounds or highly volatile fluids or gases are in the filter, they can be flushed out with water, which will replace almost any adsorbed material. The wet filter can be dried safely with hot gas after flushing.

Molecular sieves are not soluble in water, nor do they break down in the presence of heat, though strong acids will destroy them. Since regeneration temperatures can run as high as 600 F, virtually all trapped water can be driven off. Molecular sieves, therefore, will have effective drying action at temperatures as high as 400 F, a range far beyond ordinary dessicants or adsorbents. The reactivation temperature of 600 F is recommended as maximum, but a temperature of 1100 F will not break down the sieve, though repeated heating to this high temperature reduces the number of reactivation cycles the material will stand. At low temperatures, the sieves will adsorb gases as elusive as nitrogen.

The adsorbent materials are produced in three forms: a powder, 1/16 in. extruded pellets and ⅛ in. pellets. Their cost, under $2.00 per lb, puts them in a very competitive position with other adsorbents, particularly in view of their extreme stability, efficiency and long life.

Commercial production of the molecular sieves culminates about ten years of intensive research in Linde's research laboratories.

(More News Digest on page 220)



We can make your design, too

Here are seventeen drop forgings selected at random from the millions Bethlehem has made. As you can see, they vary widely in size and design. A few of them can easily be balanced on a fingertip. In contrast, the big one has to be lifted by two strong men or mechanical hoisting equipment.

No matter how different your own design may be, there's an excellent chance that we can make it for you. Bethlehem forgings are used by customers in the oil, mining, aviation, automotive, electrical, and many other industries. Through the years, many of these customers have called upon us for some pretty special service. We think they would tell you that we have done a good job for them. We can do the same for you.

Our people will welcome your inquiries. Phone or write us if anything you build requires closed-die forgings.

Complete integration helps us maintain close controls in the making of closed-die forgings. We offer a full range of equipment, including:

Modern die-sinking shops

Steam and board drop hammers (1500 to 8000 lb)

Mechanical presses to 3000 tons

Upsetters to 9 in.

Heat-treating equipment

Cleaning and inspection service

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On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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BETHLEHEM DROP FORGINGS

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Enjoy every advantage precious metal offers . . . conductivity, non-corrosiveness, high tensile . . . but pay for it only where it is needed. Improved laminated metals are *permanently* bonded together, and you get extra benefits by having a strong, non-precious base metal. Submit your specifications for prompt quotation. Start now to enjoy IMPROVED products . . . IMPROVED savings.

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Standard and special formulas developed for specific or unusual conditions. Assure the best combination of physical properties, strength in tension and compression, hardness, and ability to sustain both static and dynamic loading.

Protect moving parts from injury, scoring, and seizing due to temporary interruption or failure of lubrication.

Will not powder under the most severe conditions of service. Available rough cast or machined to precisely controlled tolerances. Can be machined at surface speeds up to 875 lineal feet per minute.

Castings to your patterns—any size, shape or section—delivered as scheduled and specified. Pattern making, designing and machining when required.

Write for free literature and service data sheets. Send blueprints, conditions of operation and other data for recommendations and quotations. You are invited to discuss your bearing problems with our metallurgists, engineers, and laboratory technicians.

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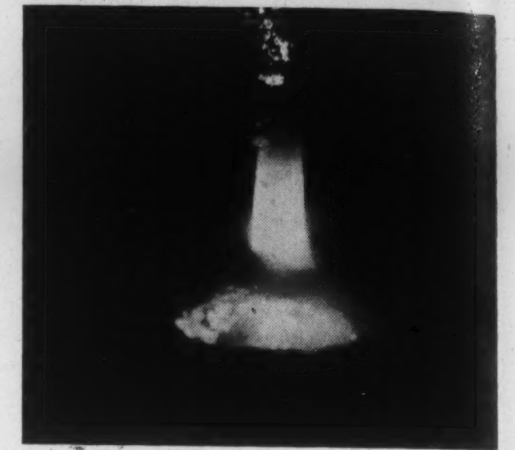
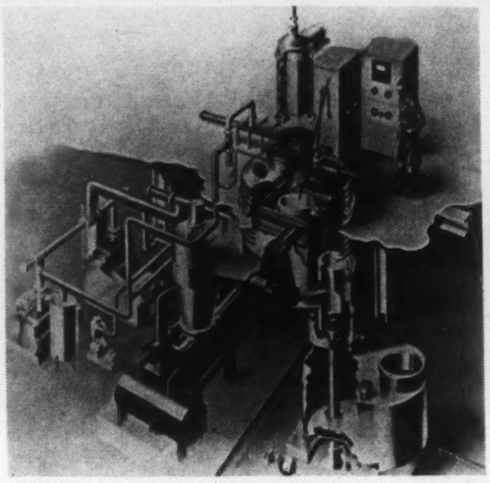


Electric arc melts molybdenum in vacuum furnace.

General Electric Co.

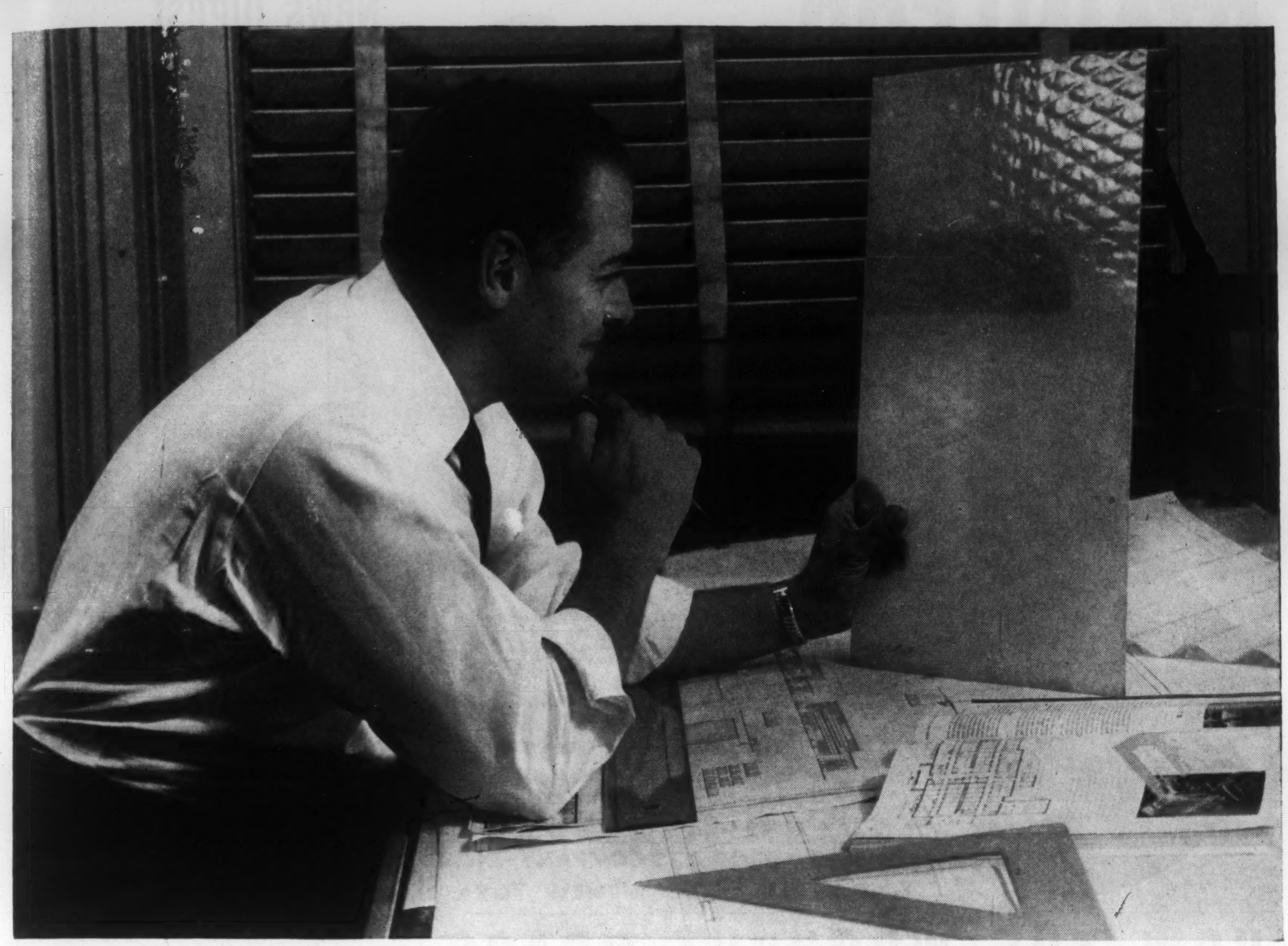


Conception of 1000-lb semi-continuous, arc-melting furnace to be installed in Carboloy plant early in 1955.

Expand Vacuum Alloy Service

Two new vacuum-melted superalloys and the addition of expanded facilities for custom melting standard alloys were announced recently by the Carboloy Department of General Electric. Carboloy reports that vacuum-melting techniques have proved so useful in developing new alloys and producing standard alloys with markedly improved properties, that investment in new semi-continuous, vacuum-melting equipment capable of producing production quantities of vacuum-melted metal is practical at this time.

The two new superalloys that are available in commercial quantities are: 1570, an alloy of high cobalt and titanium content with less nickel specifically compounded for use in jet turbine buckets; and M-252, a modification of a nickel base alloy with moderate amounts of titanium and aluminum which has been in use as an air-melted alloy for turbine



Now you can get polyester laminates with **specific flame resistance**

If it is an application where you can use the structural strength or the style imparted by modern glass-reinforced polyester sheets . . . but need *permanent, specific fire resistance . . .* ask your fabricator or molder for laminates made with HETRON® polyester resin.

HETRON's flame resistance, which distinguishes it from virtually all other resins, is chemically locked in. The result is unique stability. There is no loss of mechanical properties, as may occur when flame resistance is obtained through the use of additives alone.

HETRON resins have the added advantages of high chemical resistance, shrinkage on cure averaging 5%, a heat distortion point of 220° F. for HETRON 92, and water absorption for the same material of 0.26% after 7 days' immersion at 73° F.

In short, HETRON resins offer you all the advantages of a good polyester material—easy moldability, machinability, and adaptability—*plus* the fact that they are self-extinguishing.

We supply the resins only, but will be glad to send you names of molders and fabricators who make HETRON-based sheets. Write also for technical data and specifications on HETRON resins.

WOOD
INTERIOR FINISH
HETRON
LAMINATE

FLAME TEST proves sheet made with HETRON polyester resin does not burn freely with exposure to blowtorch flame. Veneered wood, used as basis of comparison, ignites from candle flame and burns to destruction in five minutes.

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4-1806

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For more information, turn to Reader Service Card, Circle No. 342

STAINLESS fasteners in **STOCK**

All types and sizes of screws (slotted, Phillips, socket, hex head), bolts, nuts, washers, rivets, keys and pins

- Over 9000 items in stock means *immediate delivery* from one source
- New Garden City plant now operating at *top speed and quality*
- Unsurpassed facilities for quantity fabrication of *specials*
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- *Pioneers* in the manufacture of stainless steel fasteners

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MANUFACTURERS SINCE 1929

ALLMETAL

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GARDEN CITY NEW YORK

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

** Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.

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AEF CORP

THE **AJAX WYATT** INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: Ajax Electrothermic Corporation, Ajax-Northrup High Frequency Induction Furnaces
Ajax Electric Company, Inc. The Ajax-Hultgren Electric Salt Bath Furnace
Ajax Engineering Corporation, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

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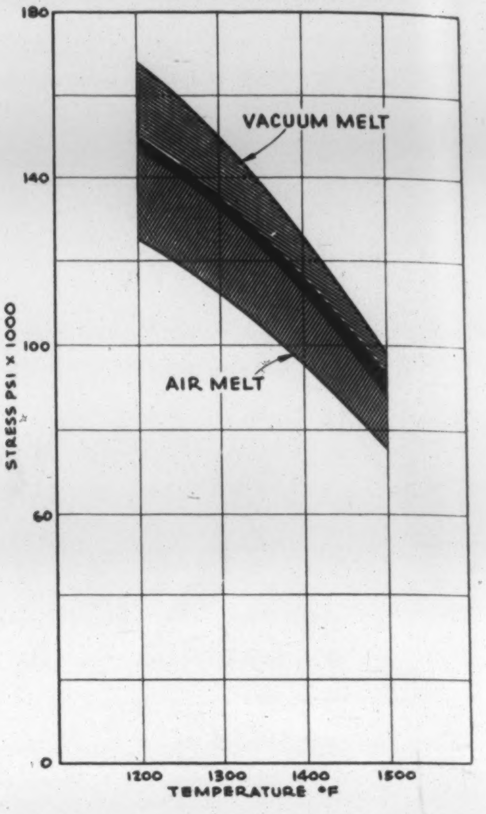
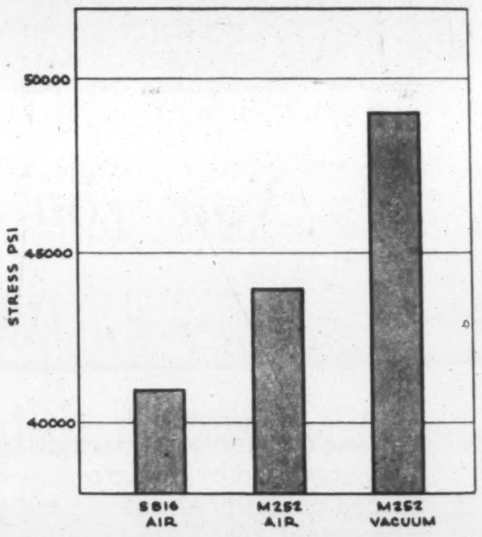
TENSILE STRENGTH AIR VS. VACUUM MELTED M252



FATIGUE STRENGTH IMPROVEMENT M252 1500 °F AND 10^8 CYCLES

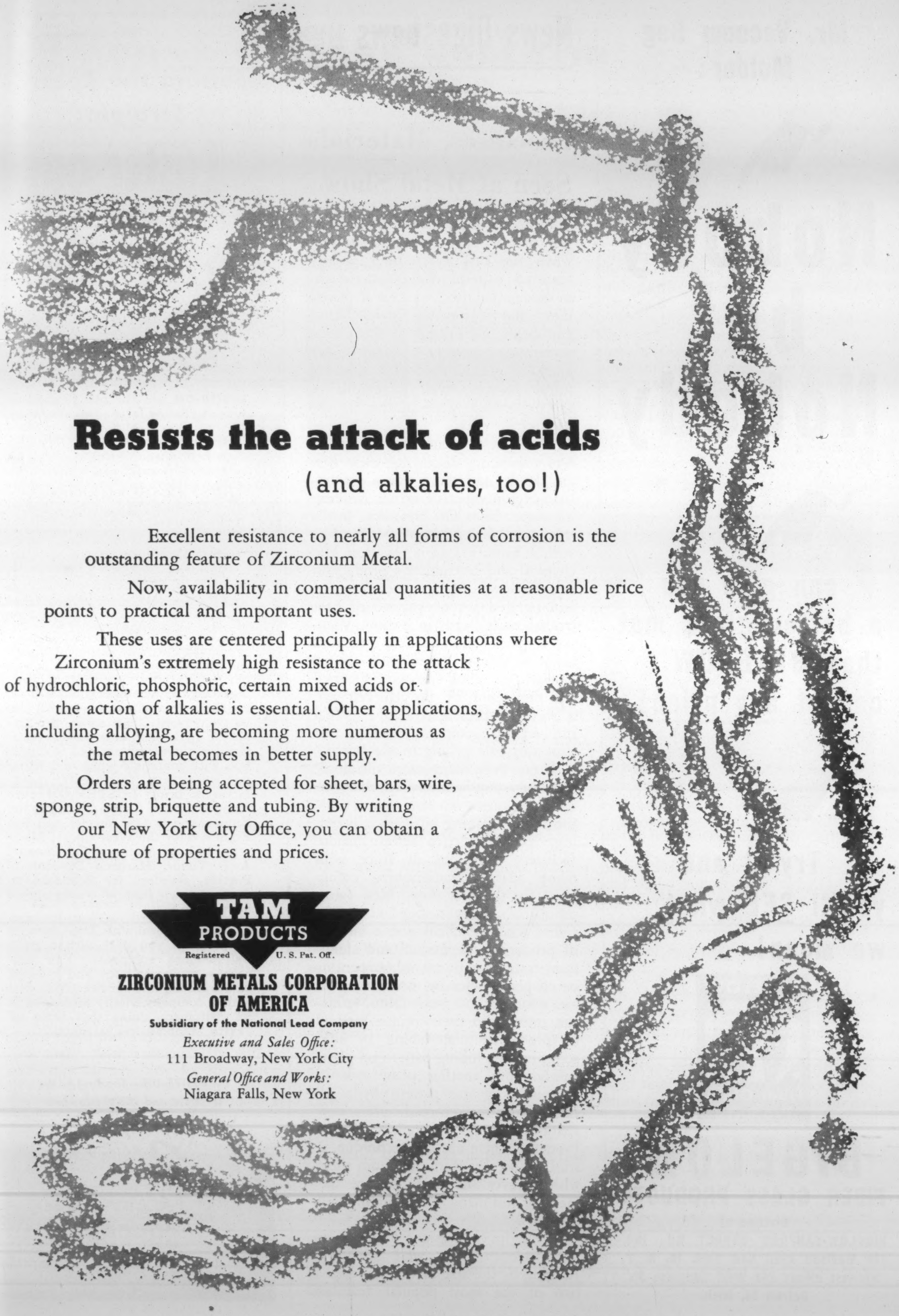


buckets. Vacuum melting 252 improves its properties and its uniformity.

The major advantages of vacuum-melting over air-melting include: 1) greater cleanliness, with significant reduction of slag and other air induced impurities; 2) closer control of chemical composition and physical and mechanical properties from heat to heat; 3) narrow hardenability range; 4) increased ductility, with some alloys realizing an increase of 3-1; and 5) greater uniformity reduces rejection rate significantly for finished work.

The two graphs are representative of some of the property improvements attainable through vacuum melting.

(More News Digest on page 224)



Resists the attack of acids

(and alkalies, too!)

Excellent resistance to nearly all forms of corrosion is the outstanding feature of Zirconium Metal.

Now, availability in commercial quantities at a reasonable price points to practical and important uses.

These uses are centered principally in applications where Zirconium's extremely high resistance to the attack of hydrochloric, phosphoric, certain mixed acids or the action of alkalies is essential. Other applications, including alloying, are becoming more numerous as the metal becomes in better supply.

Orders are being accepted for sheet, bars, wire, sponge, strip, briquette and tubing. By writing our New York City Office, you can obtain a brochure of properties and prices.

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News Digest

Processes, Materials Seen at Metal Show

A Metal Show visitor in Chicago last month may have been startled when the first eyecatching display featured a reinforced plastic automobile underbody and a set of plastic dies. But it was the Metal Show, and Bakelite's exhibit of the plastic underbody (matched metal dies) and the plastic dies (for drawing metal parts) served to emphasize the expanding scope of the big exposition.

There was plenty to see, with 444 exhibitors displaying their best and latest, and there was a greater-than-ever number of actual working displays. The Tin Research Inst.'s miniature plating line plated thimbles with a tin-nickel alloy; Wilson Mechanical and Instrument's production line Rockwell hardness tester tested and retested a conveyorload of heat treated parts; and, in Socony Vacuum's prize non-sequitur exhibit, trained chickens batted balls against a wall for their dinner. Queried for the point of the chicken act, a Socony representative said "What can an oil company exhibit? At least this gets people in the booth."

There were many more ultrasonic cleaning equipment displays this year, and all manufacturers report that the sound-cleaning business is booming. Nondestructive testing manufacturers were out in force with many offering radioisotope equipment for the first time. New fabrication techniques included Hills McCanna Co.'s Mechanacore, a method of producing magnesium and aluminum castings with curved, serpentine or off-plane holes by means of soluble nonmetallic cores. Olin-Mathieson introduced their unique method of producing plate-tubing by silk-screening the tubing pattern on plate, roll-bonding another plate over it, and inflating the pattern hydraulically. High speed thread-cutters, new spark-machining equipment, Turco Products' chem-milling technique, a stud welder for thin aluminum sheet which leaves the outer surface unmarked, and many others highlighted the show.

The technical sessions of the various societies were well attended. Judging by the size of the audiences, two of the most popular features

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LUSTER-ON was the first bright conversion coating for zinc and cadmium on the market. Although it has been widely imitated, LUSTER-ON has *always* kept ahead of the field through continuous research and development.

LUSTER-ON has consistently offered greater uniformity of results — for less cost. LUSTER-ON has offered better control in use than imitative coatings.

When you specify LUSTER-ON you get not only the finest product of its type, but the added advantage of comprehensive Chemical Corporation service and teamwork.

Members of The Chemical Corporation team are working for you in our laboratories — testing, improving. Our technical specialists will roll up their sleeves and work with you in your plant, help solve problems on the spot. Our sales and distribution team is well integrated to supply you with materials when and where you want them. Our licencee manufacturers bring LUSTER-ON even closer to you — Crown Chemical and Engineering in Los Angeles and San Francisco for the West Coast; Alloycraft Ltd. in Montreal for Canada; A B Tudor, Harbeck Division of Partille, Sweden, for Scandanavia. And our own fleet of trucks speeds delivery to you.

When you deal with The Chemical Corporation you deal with a solid, well-financed company. You deal with a company built and growing on teamwork and service. You deal with a company vitally interested in its customers, doing that little bit "extra" that assures satisfaction.

LUSTER-ON — The first in the field and still the leader!

L-13

THE Chemical CORPORATION
67 Waltham Avenue, Springfield 9, Mass.

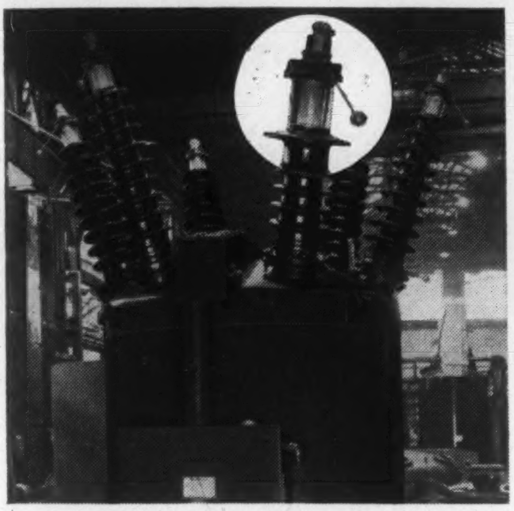
For more information, Circle No. 303

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Sunglasses for circuit breakers. If you were responsible for the health of a battery of big outdoor circuit breakers, you'd be pretty careful about maintaining the dielectric strength of the oil which is used in them.

Exposure to too much sunlight tends to cause this oil to deteriorate and undermine its dielectric strength. So Canadian Westinghouse Co., Ltd. fits circuit breakers for outdoor use with "sunglasses" on the only part where the sun can get at the oil—out near the tips of the bushings that project like horns from the breaker tank.



Actually these "sunglasses" are oil gauges, but they're made of low actinic glass and it's the "low actinic" that keeps harmful rays from sapping the strength of the oil. Here's how this glass tames wayward angstroms:

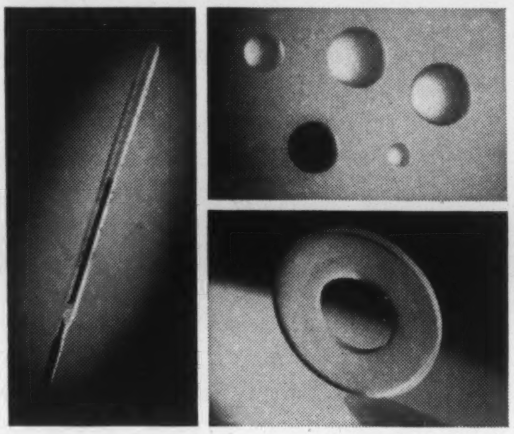
Wave length (Angstrom Units)	Percent Transmission
3000	0
4000	1
5000	4

Low actinic is just one of many special glasses Corning has developed for handling problems of radiant energy. Not only the sun's rays but rays of all kinds—from cosmic to infrared, from X- to radio—find a formidable opponent in glass.

▶ If you're interested in details, we have them for you. Just write us for our *color filter catalog*. It's full of information on how to stop some wave lengths and let others go by. Or we'll be glad to have a look at your own special ray-control problem, if you like. Our researchers are better than fair-to-middling at turning problem rays into rays of hope.

On non-human tolerance. Tolerance has a sort of chameleon-like aspect: in humans we want it broad and generous (Ralph Waldo Emerson has worked that one over pretty thoroughly); in engineering materials we often want it the opposite—narrow and close. (We'd like to work *this* one over briefly, because it's one of the things glass has that may interest you.)

Take the bore in thermometer tubing, for instance—the hole the mercury works in. It's often so small you couldn't force even a split human hair into it. But, even when we extrude it in mile-long lengths, we hold it to that dimension within a tolerance of ±.0003″.



And the glass jewel bearings which delicate instruments like potentiometers use—they're made from rods accurate to a tolerance of .0235″. We make the rods. The instrument manufacturer buys them and makes the bearings—and gets a bonus, too, because he doesn't have to final polish them with abrasives. This saves time and money.

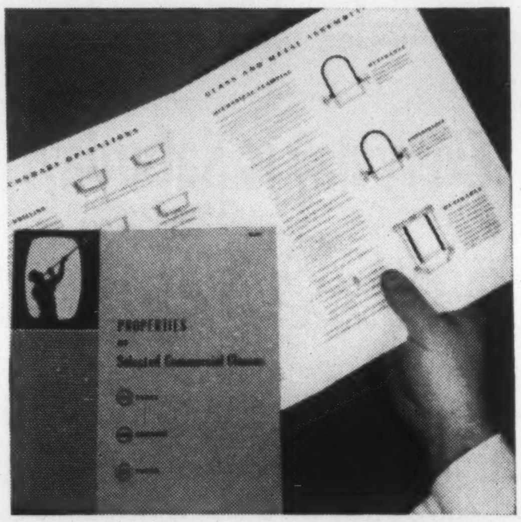
The glass rotary sealing rings shown above are part of an almost all-glass chemical pump. They keep liquids from leaking out when the pump's in action, which means they must fit tighter than tight. We make them to ±.0005″ tolerance. And we make them of VYCOR brand 96% silica glass which maintains its dimensional stability, resists acid corrosion like no other commercial material we know of, and stands the thermal shock that develops if the pump runs dry.

▶ If you'd like more on the tolerances you can hold glass to, on its ease of processing and its thermal and physical strength, the next paragraphs tell you about two books that are good reading.

Good reading, if . . . If you know an engineer who's hungering for some really technical information about this complex material called glass, you might recommend adding a couple of brass-tack bulletins to his bill of fare.

One of them condenses into fourteen pages a whale of a lot of useful information on mechanical and electrical properties, thermal stresses, heat transmission, corrosion resistance, viscosity, and other measurable attributes of PYREX, CORNING, and VYCOR brand glasses. We file it as Bulletin B-83; its more imposing title is "Properties of Selected Glasses."

The other one is Bulletin B-84—"Manufacture and Design of Commercial Glassware." It talks about glass melting. It describes the problems and limitations of designing blown glassware and pressed glassware. It gives forth on annealing and tempering, hole drilling, sealing components together, metallizing, assembling glass and metal, and other useful subjects.



▶ Neither of these booklets is the kind your engineer friend will curl up in bed with, but both can contribute to his understanding and profitable use of glass as the versatile and often surprisingly talented design and engineering material it is. We'll be glad to send you, or him, or both of you, copies.

We offer *carte blanche* service. If sun, nor reading, nor tolerances aren't currently weighing you down, let's put our heads together over whatever materials or processing problem may be specific with you right now. Could be glass has something to offer. If it has, we'll be delighted to expound at pertinent length. If it hasn't, downhearted as we'll be, we'll tell you so. May we hear from you?

Corning means research in Glass

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Every day is Saturday...

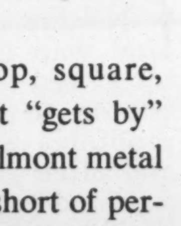
at Belmont!

If our ingots were infantrymen, they'd blow their tops! For every day—and all day—is inspection day at Belmont.

Not a single drop, square, stick, grain or ingot "gets by" the critical eye of Belmont metal experts in anything short of perfect condition... at any stage of production.

And Belmont quality is exceeded *only* by Belmont service—the result of 59 years of "falling in" on time.

Better buy Belmont... for both!



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"Putting Mettle into Metals Since 1896"

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News Digest

were the series on gaseous atmospheres and the series on titanium. Titanium seems to have definitely won its spurs as a regular feature wherever metal men gather. This year, the effect of hydrogen received great attention, replacing oxygen in the role of destructive villain.

The American Welding Society attendance was over 1400, and while not a record, was one of the highest registrations. Of all sessions, the Inert Arc welding meetings received the most attention. Discussion revealed great industry interest in the inert-arc processes and indicated that developmental activity in that field is growing apace. Carbon dioxide shielded arc welding appears to be on the horizon—and Air Reduction demonstrated the use of CO_2 for shielding welds on mild steel.

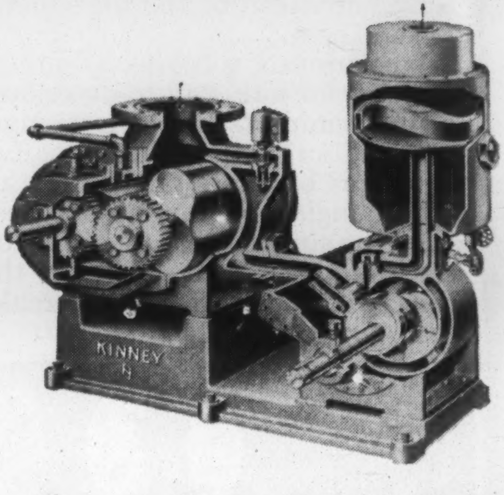
Voluntary Censorship For Technical Info

Dept. of Commerce Committee Organized

According to a memorandum released by the Department of Commerce early in November, the government plans to increase security restrictions on "unclassified strategic data" which "might be used in a manner harmful to the defense interests of the United States". Secretary of Commerce, Sinclair Weeks, announced that he was setting up an Office of Strategic Information in the Department of Commerce at the direction of the President on the recommendation of the Security Council. The office will "work with the business community in voluntary efforts to prevent unclassified strategic data from being made available to those foreign nations . . . whose interests are inimical to our own."

Secretary Weeks claimed, in announcing the program, that "such watchfulness will not take the form of censorship." However, he specified that the program would be designed to evaluate scientific, engineering and other information of a non statistical nature which, while unclassified, might be prejudicial to the national security; that it would be a matter of "exercising . . .reasonable precautions to make sure . . . that we do not provide nations

BIG BOOST
IN VACUUM PROCESSING SPEED



The new Kinney Model KMB Mechanical Booster Vacuum Pump produces four times more vacuum pumping speed per pump horsepower than any previously developed mechanical vacuum pump. This efficient pump works fast and clean . . . there is no liquid sealant in the main rotor unit to backstream into the vacuum system and contaminate the process. Kinney Model KMB has no stalling pressure—handles sudden outbursts of gas in its stride—saves valuable processing time by eliminating work spoilage and equipment downtime.

Kinney Model KMB is one of thirteen Kinney High Vacuum Pump Models—the *big line* of industry-proved vacuum pumps. Kinney district offices are staffed with competent vacuum engineers, ready to help you get the right pump for your needs. Send coupon for details.

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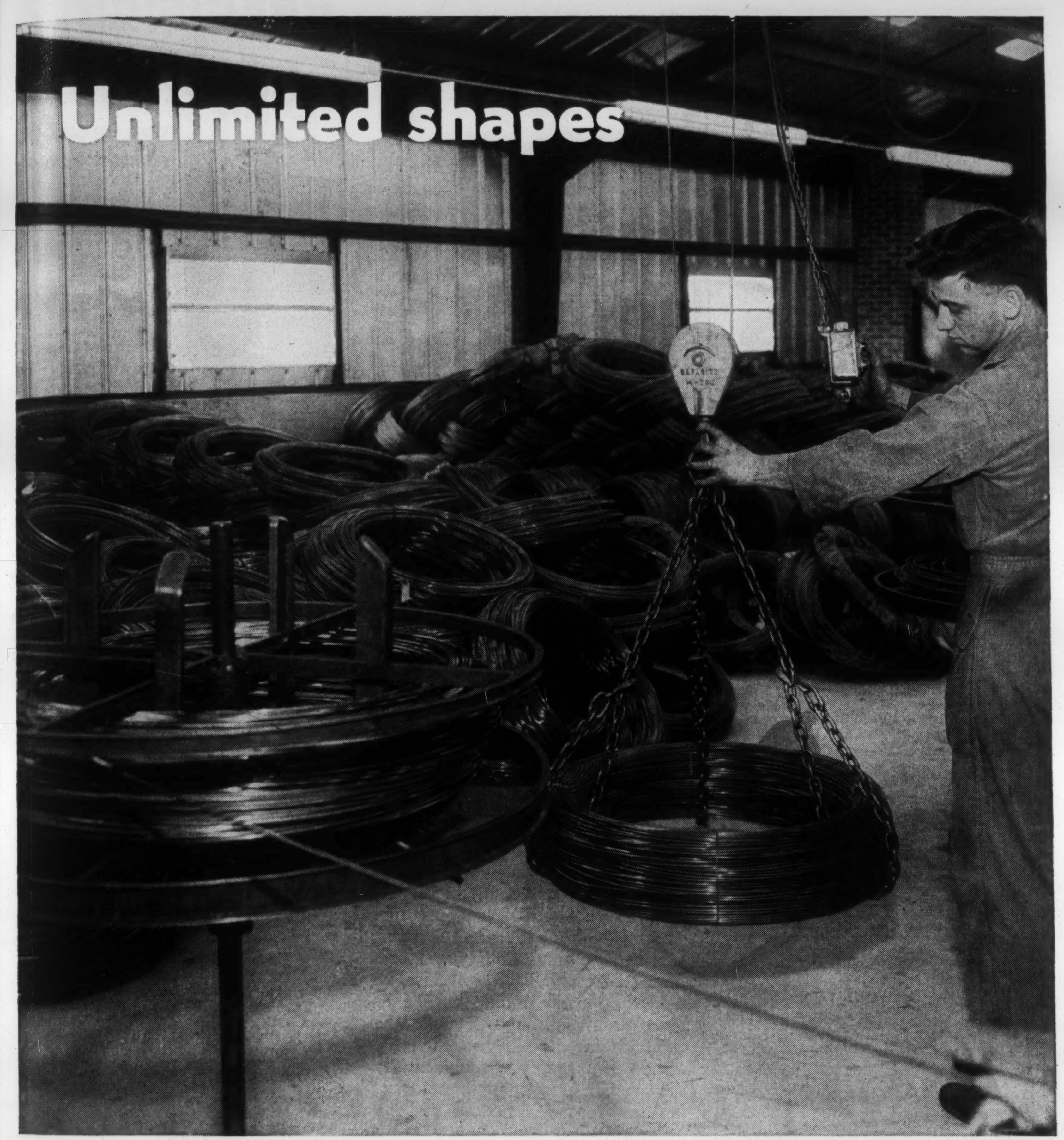

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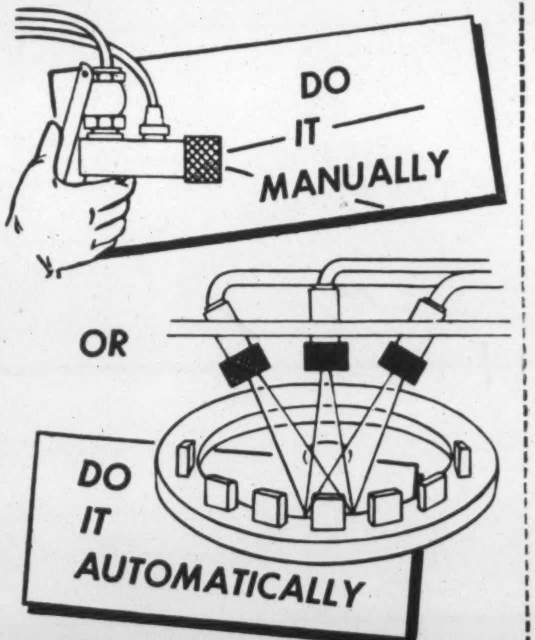

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News Digest

with material they could some day use against us"; and that the program "would require the cooperation of all who develop and disseminate our national know-how."

The Office of Strategic Information consists of five men and a special consultant. John C. Green, Acting Director of the Office of Technical Information is chairman of the Office, which is headed by R. Karl Honaman, Special Consultant and Director. Mr. Honaman is on loan from Bell Telephone Laboratories, where he is director of Publication.

Plating Process to French Concern

With a half-million dollar rights payment, the Societe Europeenne de Revetement Chimique bought exclusive sub-license rights to General American's Kanigen plating process. The Societe, a new company to be known as SEUREC, is composed of ten well-established French industrial firms.

SEUREC's initial fee of $500,000.00 covers rights to the process, and continuing royalties will be paid, based upon pounds of nickel deposited by SEUREC and its sublicensees, during the next 20 years. One-half of any sub-licensing fees received by SEUREC will also be paid to General American. The license and sub-licenses include the right to use the registered trade name "Kanigen," which identifies the practice of chemical nickel plating by General American and its licensees.

The exclusive arrangement, with sub-licensing rights, will cover the use of the Kanigen process in France, the French Union, Morocco and Tunisia; also Belgium, the Netherlands, Luxembourg, Saar, West Germany, Spain, Portugal, Switzerland, Italy, Sweden, Norway, Finland, Greece, Austria and Yugoslavia, and the respective possessions, territories, mandates and protectorates of each thereof, excepting those lying within the Western Hemisphere.

SEUREC will proceed immediately to install a pilot plant at Etablissements Studler in Paris, which will also be the first licensee for a commercial plant. This will be followed

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Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.

GORDON XACTEMP
Hand Pyrometer

A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

GORDON SERV-RITE
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Insulated in Gordon's own plant to assure consistent quality. All standard wire and insulations carried in stock for quick delivery. Other wires, in long or short runs, manufactured to specifications.

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looking for fast... low-cost *degreasing?*

Try **ALL-PURPOSE** Nialk® **TRICHLOR**ethylene

Here's an ideal organic solvent for removing practically every kind of foreign matter from metal parts. Whether it's waxes, oils, greases, tars or metal chips, you'll find that Nialk TRICHLORethylene does the job safely, thoroughly and economically, leaving parts clean, warm and dry, ready for immediate assembly, inspection or surface treatment.

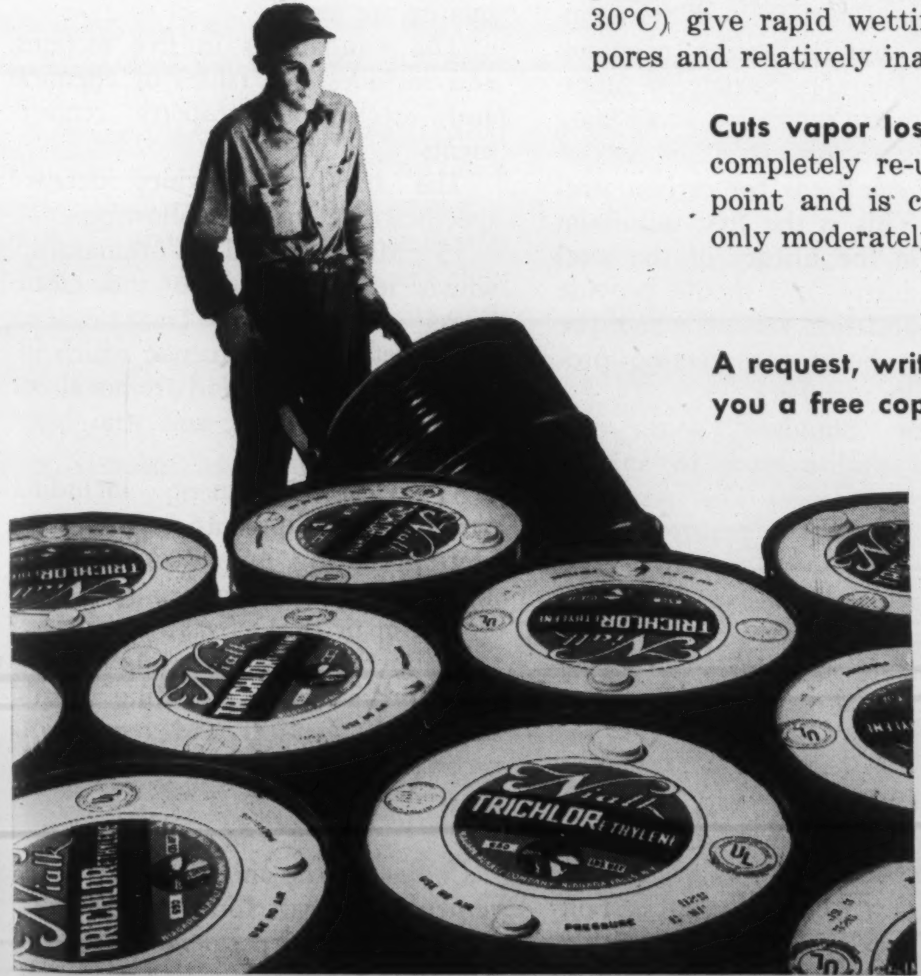
Nialk TRICHLORethylene is quick acting . . . it cleans and dries rapidly. Its low boiling range (86.6–87.8°C, based on standard ASTM tests) permits vaporization at low steam pressure. (And that narrow boiling range reflects its high purity.)

Cuts power consumption . . . Nialk TRICHLORethylene can be heated by gas, steam or electricity. Its specific heat is less than ¼ that of water. You'll get concentrated vapor at only 188°F.

Nialk TRICHLORethylene is thorough . . . its low viscosity (0.58 centipoises at 20°C) and low surface tension (about 29 dynes per cm at 30°C) give rapid wetting of surfaces, plus thorough diffusion into pores and relatively inaccessible openings.

Cuts vapor loss . . . (its vapor density is 4.5 times that of air). It is completely re-usable after distillation, has no flash point, no fire point and is classed as nonflammable at room temperature and only moderately flammable at higher temperatures.

A request, written on your company letterhead, will bring you a free copy of our Nialk TRICHLORethylene booklet.



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NIALK Paradichlorobenzene • NIALK Caustic Soda • NIALK TRICHLORethylene
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promptly by the installation of other commercial plants and the granting of other sub-licenses. All technical and operating data developed by General American's research division and General American's two Kanigen plants, in East Chicago and Los Angeles, will be made available to SEUREC. There will be an exchange of technical personnel. The French organizations included in SEUREC are:

Societe l'Aluminum Francais
M. Bertolus
Compagnie Generale d'Electro-Metallurgie
Etablissements Delattre et Frouard
Etablissements Fauvet-Girel
Forges et Ateliers de la Loire
Societe Le Nickel
Societe Simotra
Etablissements Studler
Etablissements Cail

Kanigen was introduced by General American two years ago as an entirely new type of nickel plating and is now being used extensively in industry. Its distinguishing features lie in the fact that it is purely a chemical process, it requires no electricity, and pieces of many shapes, sizes and of many basis materials can be plated with virtually zero porosity. A minimum thickness of plate is required even on extremely complicated shapes, and thicknesses can be meticulously controlled. The process was originally developed by General American to make possible the nickel plating of the interiors of tank cars to prevent contamination of fluids carried in the cars. It is now being used primarily for the plating of very large objects, of small or complicated products that cannot be economically or satisfactorily plated in the traditional way, and where virtually zero porosity is required with a minimum of plating.

Steel Founders Issue Minimum Standards

Perhaps the greatest service an industry association can provide for its members and customers of its members is a standardization program. The Steel Founders Society of America has recently succeeded in winning membership approval of a set of minimum standards for carbon steel castings. This is the first minimum standard in the history of the steel casting industry, and should provide a solid foundation around which the Society can build a marketing program for its members.

The new "Standard" is the outgrowth of studies made by various S.F.S.A. committees. The minimum standard emphasizes quality control techniques and heat treating. The society's research on machinability and design properties of heat treated castings have identified the many benefits that accrue through proper heat treatment.

The Minimums

Recommended minimum standard applies to steel castings commonly referred to as "commercial carbon steel castings" (readily weldable grade). The minimum, of course, will apply only when no specifications calling for another order of quality are made.

The standard is in five sections, and includes two tables of chemical and mechanical property requirements.

The standard provides detailed specifications for the following:

1) Material and Workmanship, which involves surface and cleanliness;

2) Detail Requirements, which include dimensions and removal of risers, weight limits, and straightening operations;

3) Heat Treatment, including pyrometric equipment requirements, heating, cooling, normalizing, annealing and stress relieving;

4) Repair of Defects;

5) Methods of Sampling Inspection and Testing, including tensile sampling, chemical and mechanical property limits.

Copies Available

Copies of the minimums, in convenient wall-chart form, are available from the Steel Founders' Society of America.

PYRO
Instruments for Precision Temperature Measurements

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Radiation Pyrometer
Tells spot temperatures instantly in heat-treating furnaces, kilns forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature indicated on direct-reading dial at a press of the button. Any operator can use it. Two double-ranges from 1000° F. to 3400° F. Write for FREE Catalog No. 100.

PYRO
Optical Pyrometer
Determines temperatures of minute spots, fast-moving objects and smallest streams—at a glance! No correction charts or accessories needed. Easy to use—weights only 3 lbs. Special types available to show true spout and pouring temps. of molten ferrous metal measured in open. Five stock rangees. From 1400° F. to 7700° F. Write for FREE Catalog No. 85.

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The ideal instrument for all plant and laboratory surface and sub-surface temperature measurements. Available with large selection of thermocouples and extension arms for all jobs. Designed for ruggedness and accuracy . . . it features automatic cold end compensation, large 4¾" direct reading dial and shock, moisture and dust-proofed shielded steel housing. 5 stock ranges 0-300°F. to 0-1200°F. Ask for catalog No. 168.

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The Pyro Immersion Pyrometer is shock proof, moisture proof, dust proof, immune to magnetic influences. Shielded steel housing. Instantly interchangeable thermocouples without adjustment or recalibration. Large 4" scale. Equipped with exclusive Lock Swivel. Ranges 0-1500 to 0-2500 F. Get FREE Catalogue No. 155.

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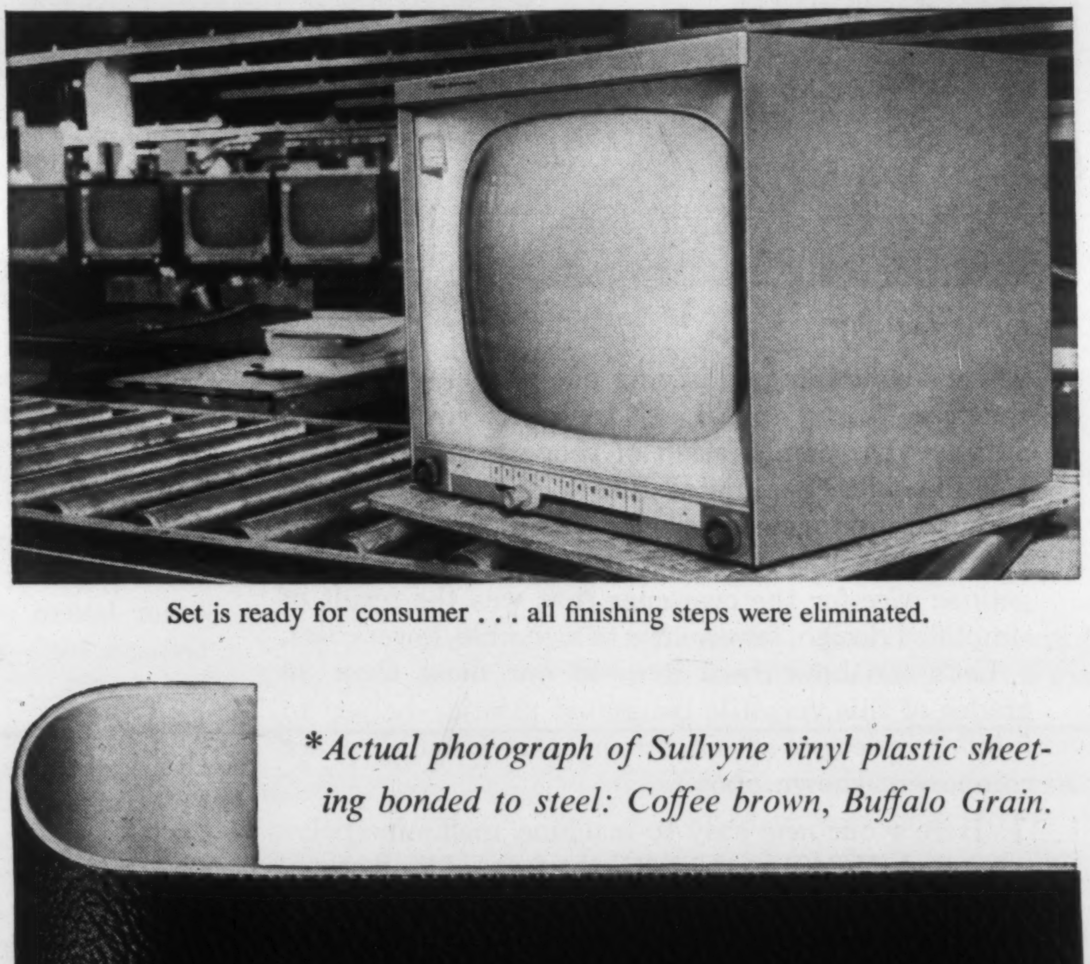
Sullvyne-Clad® Metal Laminate is Pre-Finished

...goes from forming to final assembly

On the assembly line at CBS-Columbia, television cabinets are made in two simple steps.

Pre-finished sheets are punched and formed.

Completed Cabinet is placed over chassis.



Set is ready for consumer . . . all finishing steps were eliminated.

SULLVYNE-CLAD is a pre-finished sheet made to your specifications with smooth or embossed vinyl sheeting laminated on steel, aluminum or magnesium. Sizes up to 52" x 120".

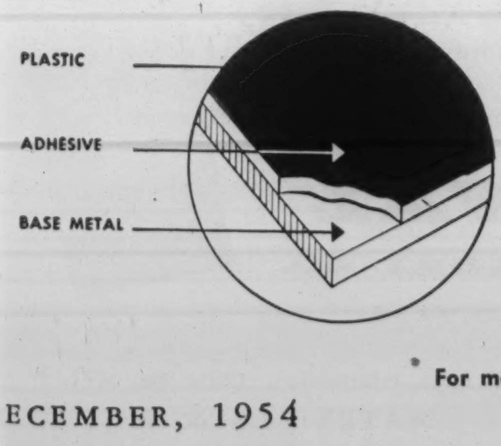
Sullvyne-Clad is completely flexible, ready for your production line. Process it with your standard tools. Stamp it, punch it, crimp it, deep-draw it, or bend it 180° without damaging the vinyl or breaking the bond.

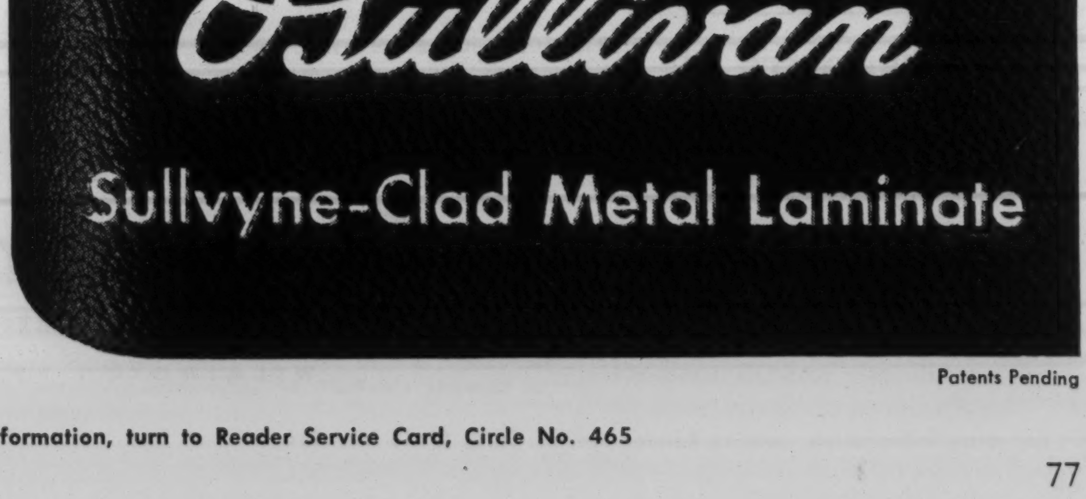
No special dies or drawing compounds are necessary. Bond strength will vary according to the metal used and the thickness of the vinyl laminate—the average is 35 lbs. per inch.

Sullvyne-Clad slashes service costs; gives you an unequalled finish ten times thicker than any conventional coating—.012" to .030". It has positive resistance to abrasion and corrosion; won't chip, crack or craze; far superior to any ordinary paint, lacquer or enamel.

Sullvyne-Clad is available in a wide variety of colors, patterns and embossings. Samples free on request.

METAL LAMINATE DIVISION
O'SULLIVAN RUBBER CORP.
WINCHESTER, VIRGINIA
Makers of America's No. 1 Heel





**Actual photograph of Sullvyne vinyl plastic sheeting bonded to steel: Coffee brown, Buffalo Grain.*

Patents Pending

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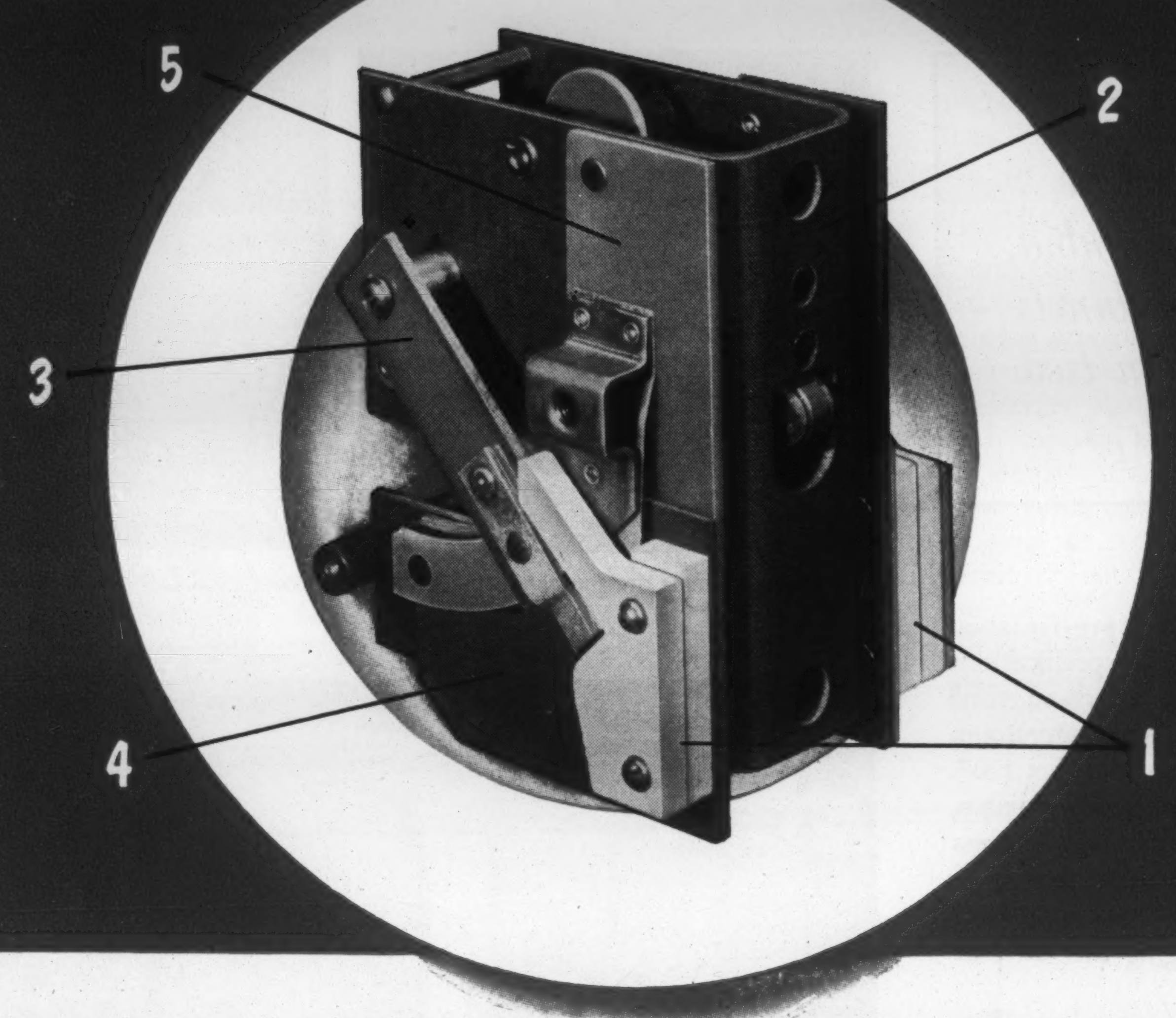
a 5 course "dinner" of Phenolite



There's something satisfying about a base material that can "serve up" almost anything you want, no matter what combination of properties are needed. Yet Phenolite Laminated Plastic did just that for a manufacturer of electrical equipment . . . then topped off the "meal" with an attractive dessert—a *competitive edge* for the customer that was the result of simplified design, fewer parts to assemble, lower costs.

Let's see how these five—of our more than 35 grades of this versatile laminated plastic—helped to fulfill a variety of specifications in the circuit breaker component shown above.

1 Here's our *new* easy-to-machine melamine-polyester grade Y-2401 on the job in the form of limit stops. Supplied: arc and impact resistance to a high degree.

2 A post-forming grade becomes the chassis, eliminating need to insulate other parts from it. Supplied: great strength, close-tolerance forming, dimensional stability.

3 This particular grade of Phenolite supplies the extreme toughness called for by the contact arm.

4 The arc breaks right above this insulation plate made of a special Phenolite sandwiched between outer layers of our vulcanized fibre. Supplied: extremely high arc resistance, strength to hold adjoining parts.

5 For this mount plate, which supports much of the mechanism, another grade of Phenolite provides great mechanical strength.

Our engineers have helped to put versatile Phenolite on the job in thousands of electrical, chemical and mechanical applications. Their many-sided experience is yours for the asking. Write today.

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Laminated PLASTIC

FOR YOU . . . just off press . . . our 12-page booklet "Champ" Phenolite. Tells—at a minimum of your reading time—why you can make it *better* with Phenolite. Call our nearest office for your copy (see classified directory). Or write us at Wilmington 99, Delaware, Dept. D-12.

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. . . through Chemistry

PRODUCT ENGINEERING NEWS

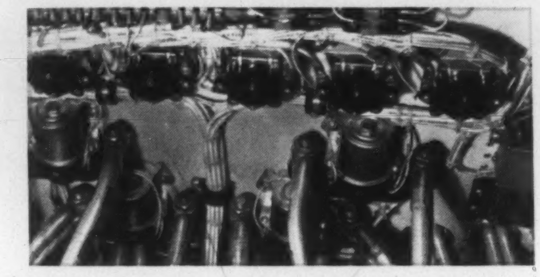
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 6 — 1954

Packing of Du Pont TEFLON® Functions after Two Years' Service in Fuming Sulfuric Acid Pump

Lightweight "Zytel" nylon resin useful in aircraft wiring systems

THE properties of Du Pont "Zytel" make this versatile engineering material particularly adaptable for electrical systems.



Sixteen miles of cable jacketed with "Zytel" are used in one airplane. The thin, abrasion-resistant nylon jacket assures a durable insulation.

"Zytel" is used for cable clamps, strain-relief clamp blocks, grommets, wire guides and support blocks, terminal blocks, and similar devices.

Du Pont "Zytel" is specified for these applications because it is tough, resists abrasion and extremes of temperature, and has the necessary dielectric characteristics. It can be molded into intricate shapes . . . is strong in thin sections.

These same properties of "Zytel" are utilized in cable jacketing. One type of airplane carries sixteen miles of cable jacketed with "Zytel". Another property is also important in aircraft—resistance to attack by petroleum products.

Du Pont "Zytel" is used continuously at temperatures normally found in commercial electrical equipment (to about a maximum of 250°F).

Many manufacturing economies are obtained with "Zytel". Injection-molding technique allows rapid molding of complicated shapes. Often a single part molded of "Zytel" nylon resin replaces an assembly. And, because "Zytel" can be molded around metal inserts, further design simplification is often possible.

"Zytel" is the new trade-mark for Du Pont nylon resin.

Chemically inert, "Teflon" performs equally well as packing, gasket, impeller

DU PONT "Teflon" tetrafluoroethylene resin has proved its versatility many times in applications where conditions were so severe that no other engineering material was adequate.

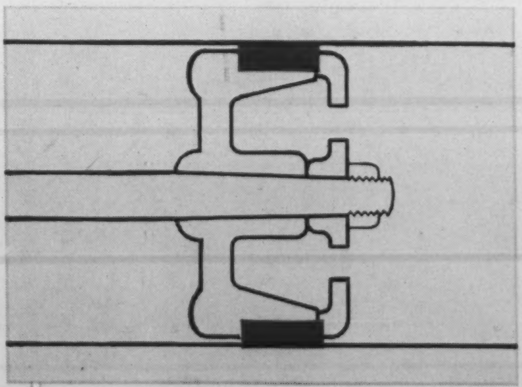
Here are a few examples of outstanding performance by "Teflon":

Application 1. When conventional packing was used in the handling of fuming sulfuric acid, repacking was necessary every two days. Pumps packed with "Teflon" have not needed repacking in two years.

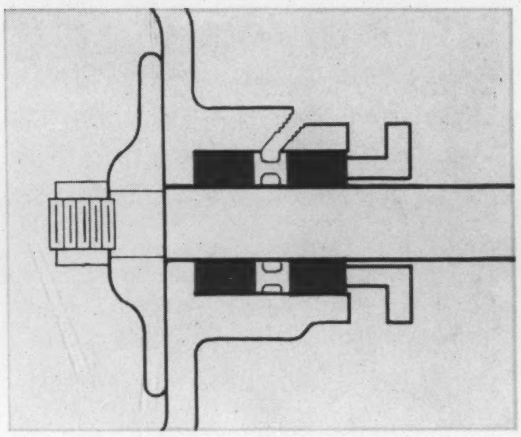
Application 2. One step in the manufacture of pyribenzamine involves thionylchloride in the presence of boiling solvents—a very corrosive mixture. Gaskets of "Teflon" were still in good condition after over a year, while gaskets of other materials deteriorated within a few weeks.

Application 3. Leakage with previous packing in a reciprocating pump handling diacetone was one-half pound per *hour;* leakage with packing of "Teflon" is only one-half pound per *week.*

Application 4. When a pump, worn out from handling silicon tetrachloride at 2000 to 2500 p.s.i., was returned to the manufacturer for servicing, the original packing of "Teflon" was still intact. The former packing required servicing every two or three days.



After many months' service on this horizontal duplex pump, rings of "Teflon" showed no signs of wear.



Packing of "Teflon" on this centrifugal pump gives long life, cuts maintenance costs.

There are many reasons why "Teflon" tetrafluoroethylene resin performs so well in so many ways—as packing, gasket, or impeller.

For one thing, "Teflon" is inert to all chemicals and solvents normally encountered in industry. Only exceptions are molten alkali metals, fluorine gas at high pressures and temperatures.

"Teflon" remains tough at temperatures as low as −450°F. It is capable of continuous service at 500°F. The tendency of "Teflon" to cold-flow is not excessive, and is confined to the first few hours after compressive load is applied.

"Teflon" resists heat, has zero water-absorption by ASTM test D570-42, and is unaffected by outdoor weathering. For impeller use, "Teflon" is self-lubricating, has a low coefficient of friction, will not shrink, swell, or crack.

This unique engineering material may help you to simplify designs, reduce maintenance costs, improve process performance. Clip the coupon on reverse side for more information about Du Pont "Teflon" tetrafluoroethylene resin and its applications.

OVER

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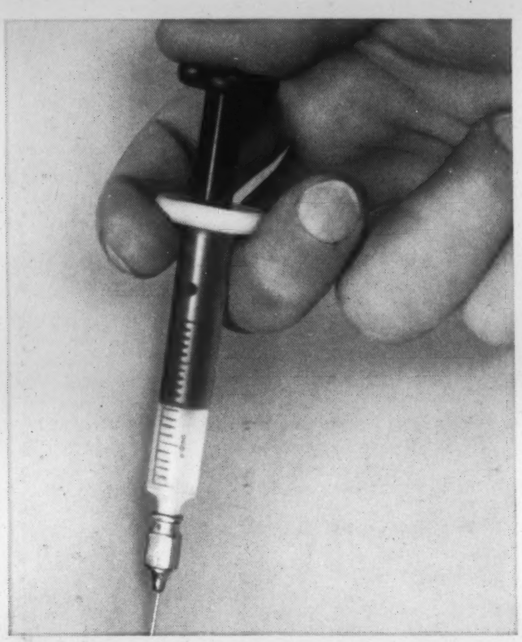
. . . through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 6 — 1954



Both plunger and barrel of 2cc hypodermic syringe are molded of Du Pont "Zytel" nylon resin. These parts are unbreakable, and can be sterilized with dry heat, by boiling, or autoclaving. Syringe is manufactured by Nelson Products Company, of Arlington, New Jersey.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"** nylon resin are helping solve industrial design problems.

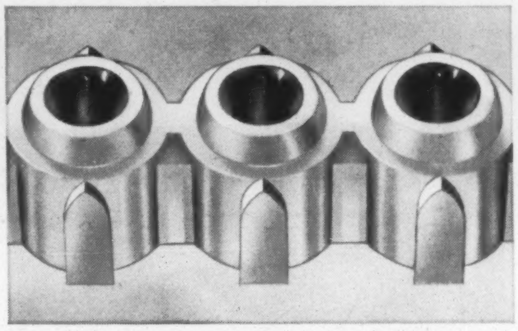
NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

Battery sealers of Du Pont "Alathon" fit tightly, won't corrode

The Electric Storage Battery Company, of Philadelphia, Pa., uses positive-plate tube sealers of Du Pont "Alathon" polyethylene resin for the Exide-Ironclad battery. Molded "Alathon" and its versatile properties have effectively lengthened the working life and improved the performance of this industrial battery.

Du Pont "Alathon" is resilient, assuring a tight fit where the sealers cap the plates. Because "Alathon" resists electrolyte and electrolytic action, these battery sealers reduce loss of active material and effectively lengthen battery life. And non-corrosive "Alathon" insulates the plate bottoms, preventing short circuits.

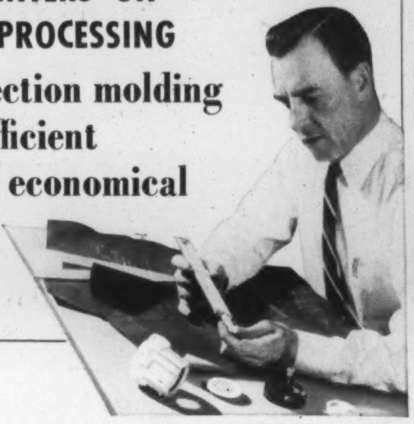


These intricately shaped sealers of Du Pont "Alathon" polyethylene resin are rapidly mass-produced by means of injection molding.

Be sure to evaluate the versatile combination of electrical, mechanical, and chemical properties of Du Pont "Alathon" polyethylene resin. These properties may help solve your own design problems. For more information, clip the coupon below.

POINTERS ON PROCESSING

Injection molding is efficient and economical



Injection molding, as a method of mass-producing parts made of Du Pont engineering resin materials, has been developed mainly within the past ten or fifteen years. Improved techniques have accompanied that development.

Injection molding offers the advantages of high production rates, low unit cost, and usually does away with finishing operations. One important saving which has been effected by injection molding occurs when the molded piece replaces an assembly of parts.

High Production Rate. Multicavity dies have been made which produce hundreds of identical pieces at a time. Molding time and cycle vary with the size of the part and its shape. The injection-molding process is versatile, and is used to produce a wide variety of quality parts, rapidly and economically.

Low Unit Cost. Another positive value of injection-molded parts is the low cost of fabrication per part. While the initial cost of the mold itself is high, a mass-production operation makes the cost per piece low. Loss of molding material is generally low, too.

No Finishing Operations. With good molding techniques, pieces can be injection-molded to close tolerances. In many cases, molded pieces require no finishing operations. Thus, large savings in time and expense can often be realized.

Simplified Designs. The versatility of injection molding often permits design simplification. Du Pont "Zytel", for example, can be injection-molded into intricate shapes, as well as around metal inserts. Du Pont "Alathon" polyethylene resin and "Lucite" acrylic resin can also be successfully injection-molded into a variety of useful forms.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 1112, Du Pont Building, Wilmington 98, Delaware.

*Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for:*________

NAME________ POSITION________
COMPANY________
STREET________
CITY________ STATE________
TYPE OF BUSINESS________

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*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
**"Zytel" is the new trade-mark for Du Pont nylon resin.

HONITE Method Gives Better Finishes Faster

HONITE field engineer helps manufacturer save up to 50% on barrel finishing

Argus Cameras, Inc., Ann Arbor, Michigan, had been using barrel finishing since 1945—processing 175 different kinds of zinc, aluminum and steel camera parts such as those shown above. Last year HONITE Field Engineer D. J. Jones supervised a change to the HONITE Barrel Finishing Method.

Sample results? Recommended HONITE procedure helped cut finishing time on zinc die-cast levers from 36 hours to 15 hours—a time-saving of 58%.

Costs of deburring and polishing aluminum camera-case castings were reduced from $.118 per unit to $.059—with rejects cut from 54% by the old method to 7% with the HONITE method.

Now—the company has found that the HONITE method cuts costs, increases production on intricate parts of all sizes. As many as 500,000 parts are processed weekly.

Your HONITE Field Engineer or nearby HONITE Distributor is a barrel finishing expert who can help *you* cut barrel finishing costs, too. Call him today!

Honite®
BRAND

Made in U.S.A. by Minnesota Mining and Mfg. Co. General Offices: St. Paul 6, Minn. In Canada: London, Ont., Can. Export: 122 E. 42nd St., New York City. Makers of "Scotch" Pressure-sensitive Tapes, "Scotch" Brand Magnetic Tape, "3M" Adhesives, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing.

Honite
Barrel Finishing Manual

Minnesota Mining and Mfg. Co.
Dept. MM-124, St. Paul 6, Minn.

☐ Send me free copy of "3M Barrel Finishing" Manual

☐ I'd like to talk with a HONITE Sales Engineer

NAME________________ TITLE________

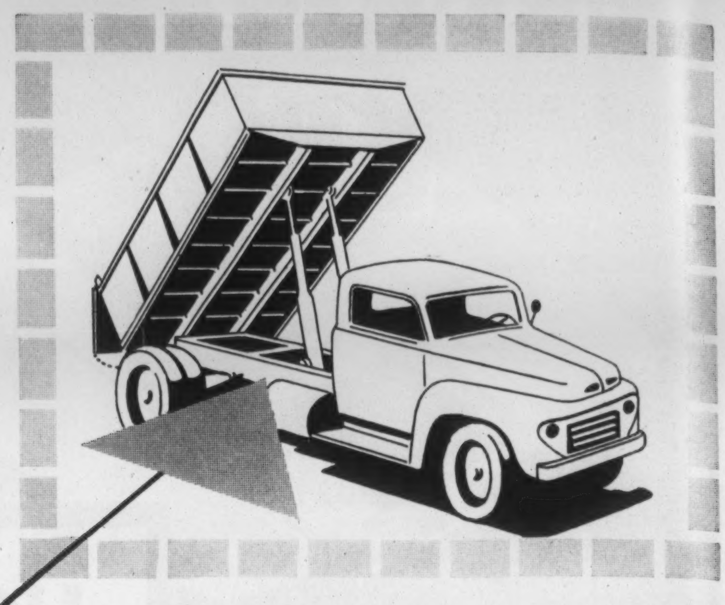
COMPANY____________________

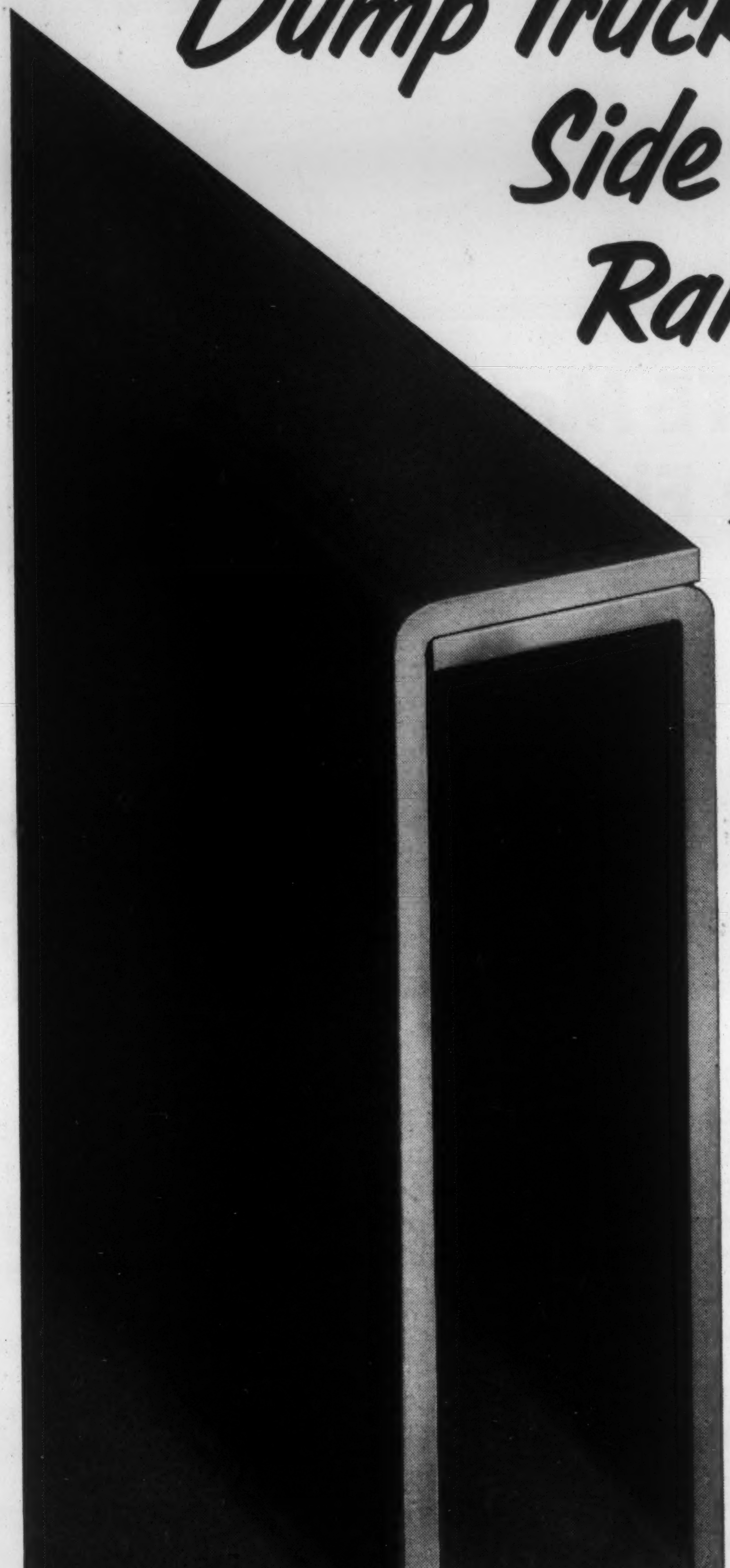
ADDRESS____________________

CITY____________ ZONE____ STATE______

Type of products to be finished______________

• For more information, turn to Reader Service Card, Circle No. 452





Dump Truck Side Rails made from Cold-Formed Shapes

These two sturdy shapes — a Z section and a channel — form a rigid base to support the body-tilting sections of hydraulic dump trucks. Formed cold from steel sheets, they are supplied to the manufacturer in lengths of approximately 10 ft. Installation of these shapes on the truck bodies requires a minimum of preparation and shop work, since they are formed accurately to customer specifications.

Cold-Formed Shapes in Your Product

There's a good chance that you can use a Bethlehem Cold-Formed Shape to advantage in your product. The possible applications of these shapes are almost limitless — lately we've made them for use in ornamental railings, storage racks and industrial conveyor systems, to name only a few.

Bethlehem Cold-Formed Shapes come in any gage of strip, sheet or plate steel from 5 to 24. The most simple of pencil sketches submitted with your inquiry will enable our engineers to turn your idea into a practical and economical product.

A request to the nearest Bethlehem sales office will bring you our booklet on Cold-Formed Shapes. Or our representative will be glad to call on you and discuss your needs in detail.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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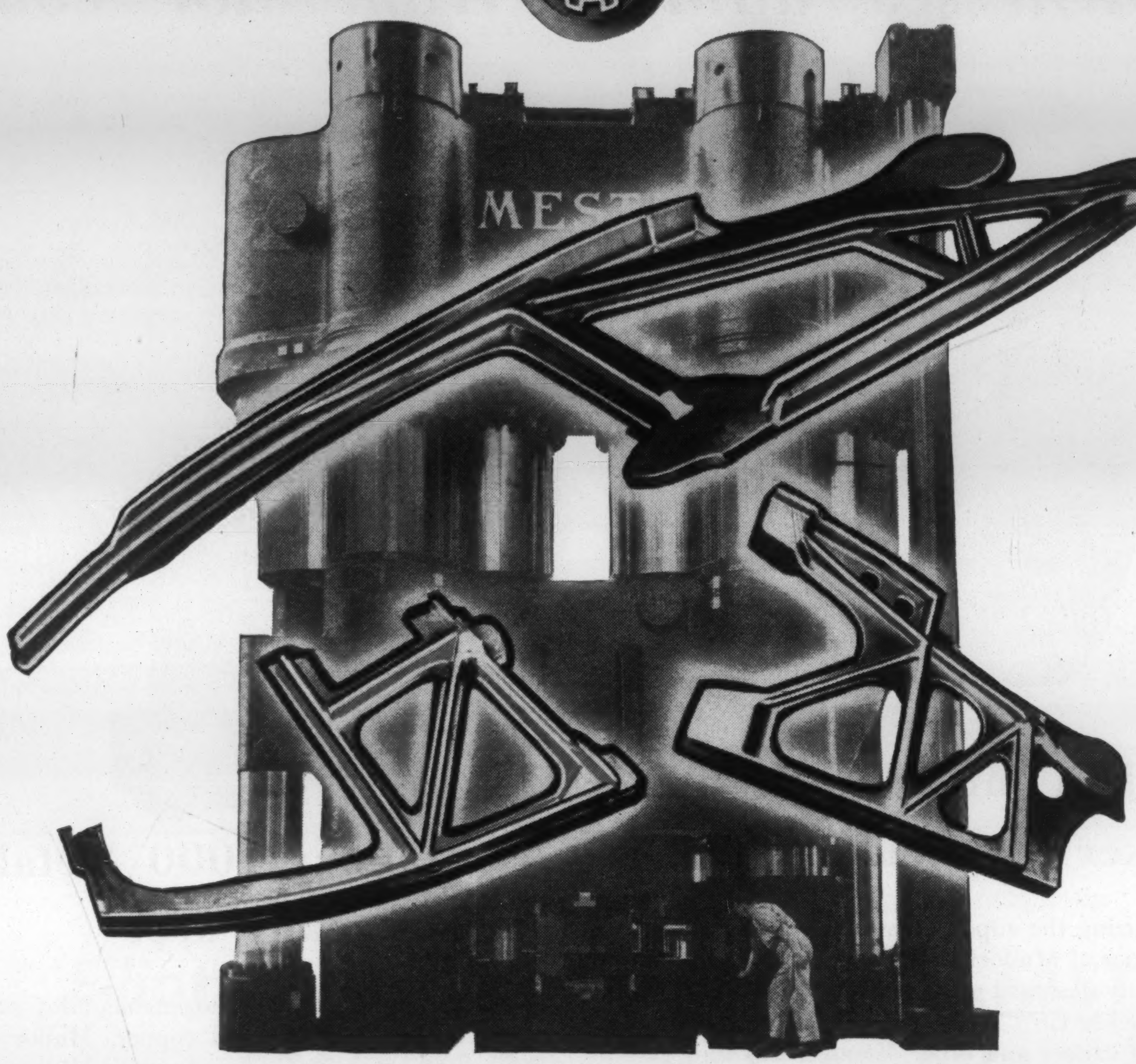

Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000 ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

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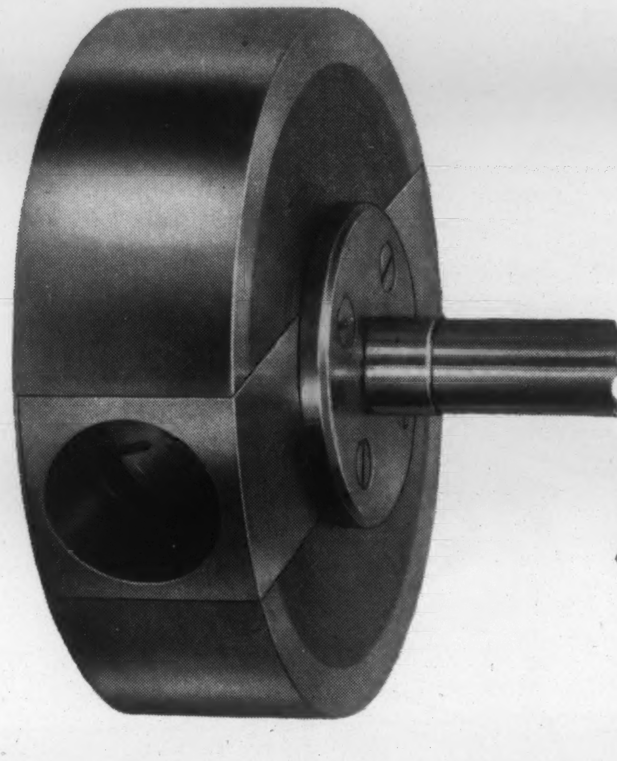
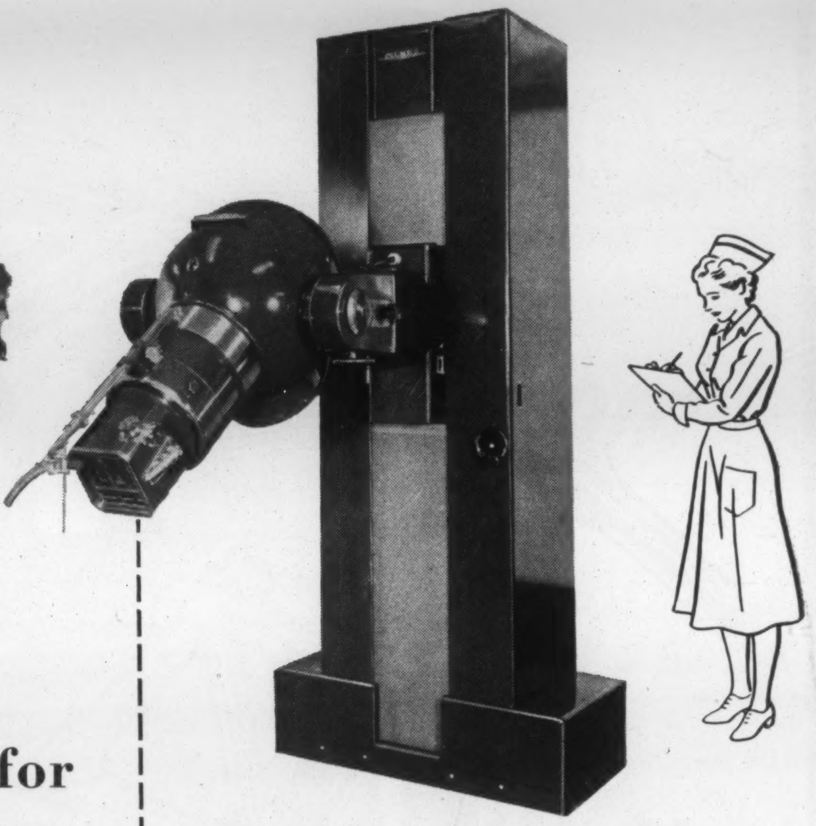
Mallory 1000 Metal Shield

harnesses radiation from "hot" cobalt





. . . used in "on-off switch" for Picker Co⁶⁰ Teletherapy Unit

By utilizing the superior radioactive shielding characteristics of Mallory 1000 Metal, the Picker X-Ray Company designed greater safety and flexibility into their Picker Co⁶⁰ Teletherapy Unit. Used for treatment of cancer and other diseases, this unit gets its energy from radioactive cobalt, a few wafers of which have the power of 3-million volt x-ray.

The cobalt 60 radiates continuously. To control its radiation for safe, flexible treatment, a special "switch" was designed of Mallory 1000 Metal as shown here. Into the block goes a receptacle, also of Mallory 1000, which holds the cobalt source. Effectively confined by its shield, radiation can come out only through a narrow hole in the receptacle. This compact assembly is mounted inside a lead ball. By rotating the Mallory 1000 shield, radiation can be allowed to come out through an aperture in the ball or can be "switched" off.

Expect More . . .
Get More from **P.R. MALLORY & CO. Inc. MALLORY**

Mallory 1000 Metal has many uses

A high density, homogeneous alloy of tungsten, nickel and copper, Mallory 1000 is fabricated by advanced Mallory powder metallurgy techniques. It is an ideal radiation shielding material . . . has up to 40% greater absorption than lead. Furthermore, its extreme density, 16.96 grams per cc., provides an excellent material for balance weights and rotors where size must be restricted. It is high in tensile strength and is easily machined to a fine finish.

We can save on your production costs by supplying Mallory 1000 in intricate shapes, made by our exclusive contour pressing technique, to reduce substantially your finish machining expense. Write today for Technical Bulletin on this versatile material.

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Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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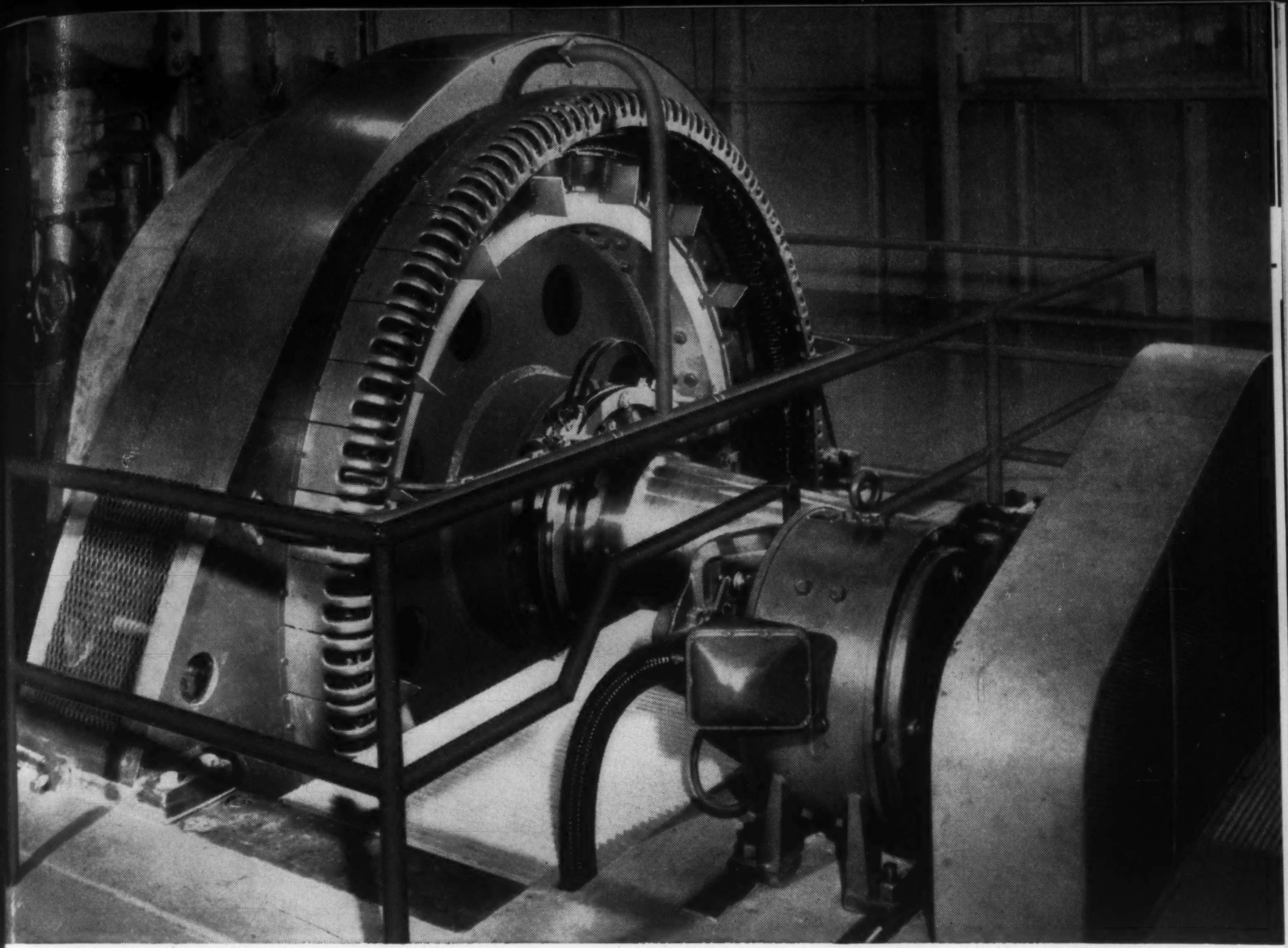
For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

For more information, turn to Reader Service Card, Circle No. 357



Elliott gets spider rim forgings FAST from STANDARD STEEL WORKS

Fast service on key forgings is mighty important to the Elliott Company. That's one of the big reasons why they have been depending on Standard Steel for years to supply spider rim forgings for their synchronous generators.

The urgent need for more and more electric power in this country makes it imperative for Elliott to keep production moving. Output would be stymied completely if they had to wait at all for delivery of their spider rim forgings which are the very heart of the rotor assembly. Fortunately they have found a truly dependable source . . . the Standard Steel plant in Burnham, Pa.

Elliott's experience is typical, because Standard Steel has unequalled facilities and experience to produce highest quality steel forgings . . . quickly and consistently. Proof of dependable performance is the continuing growth of Standard Steel for over 150 years.

Maintain your production schedules . . . improve product quality . . . by standardizing on Standard Steel as your source for forgings and castings.

For more information about SSW's ability to produce forgings and castings of unusual sizes and shapes (such as weldless rings up to 144'' O.D.) please write Department 8823:

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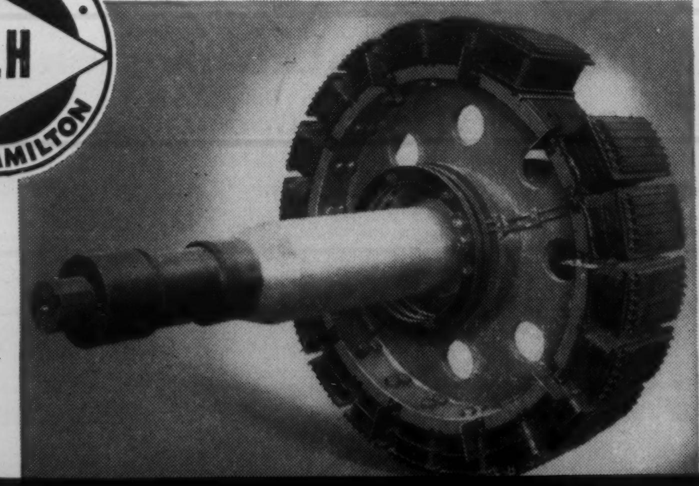

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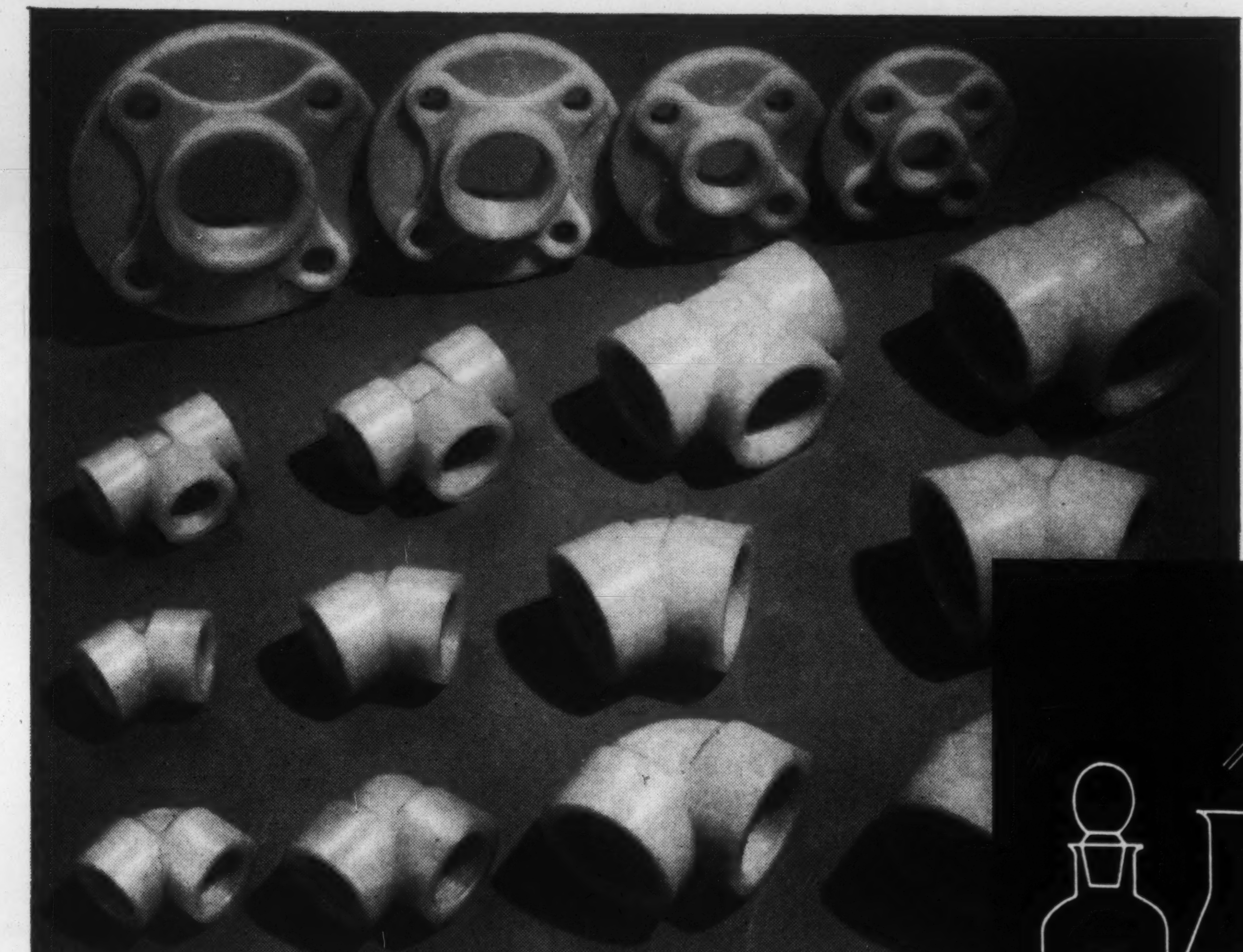
unplasticized P.V.C. now can be MOLDED for unlimited low-cost, corrosion-resistant applications



EXON 402-A

—using Firestone

Exon 402-A truly is a most versatile resin!

It makes possible molded unplasticized P.V.C.—opens wide new horizons for many low-cost, high-strength, corrosion-resistant applications—in an infinite variety of sizes and shapes.

It's no great news that unplasticized P.V.C. pipe has long been available. But it is exciting news that you can now use Exon 402-A to quickly turn out pipe fittings of Standard I.P.S. sizes ½" through 4", slip-fit or threaded. The products shown here are absolutely uniform . . . with excellent chemical resistance and inertness. Imagine the limitless possibilities this material offers in the pipe field alone!

Exon 402-A used to mold products made of unplasticized P.V.C. could easily end *your* search to cut costs in processing tough, corrosion-resistant products. For complete details on the many advantages, uses and applications of Exon 402-A, contact Firestone today.

for complete information
on the entire line
of Firestone **EXON** resins,
call or write:

CHEMICAL SALES DIVISION
Firestone Plastics Company
Dept. 3H
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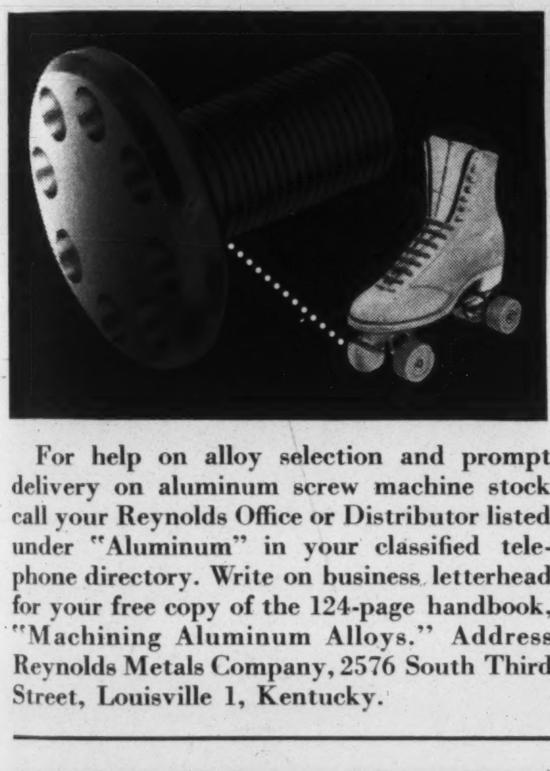
ALUMINUM IMPROVED AS ELECTRICAL CONDUCTOR

Aluminum Screw Machine Skate Part Has Strength Without Weight

The skate toe stop shown below is made by Ware Brothers Division of Chicago Roller Skate Company. Reynolds 2011-T3 aluminum screw machine stock was selected for the part because it offers ample strength and mass yet is light in weight. This manufacturer of quality skates also uses a forged aluminum foot plate for the same strength to weight advantage.

Job for job, aluminum alloys machine at greater speeds and feeds, thus stepping up production. Unit costs for material, handling and shipping step down because of aluminum's light weight with strength.



For help on alloy selection and prompt delivery on aluminum screw machine stock call your Reynolds Office or Distributor listed under "Aluminum" in your classified telephone directory. Write on business letterhead for your free copy of the 124-page handbook, "Machining Aluminum Alloys." Address Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

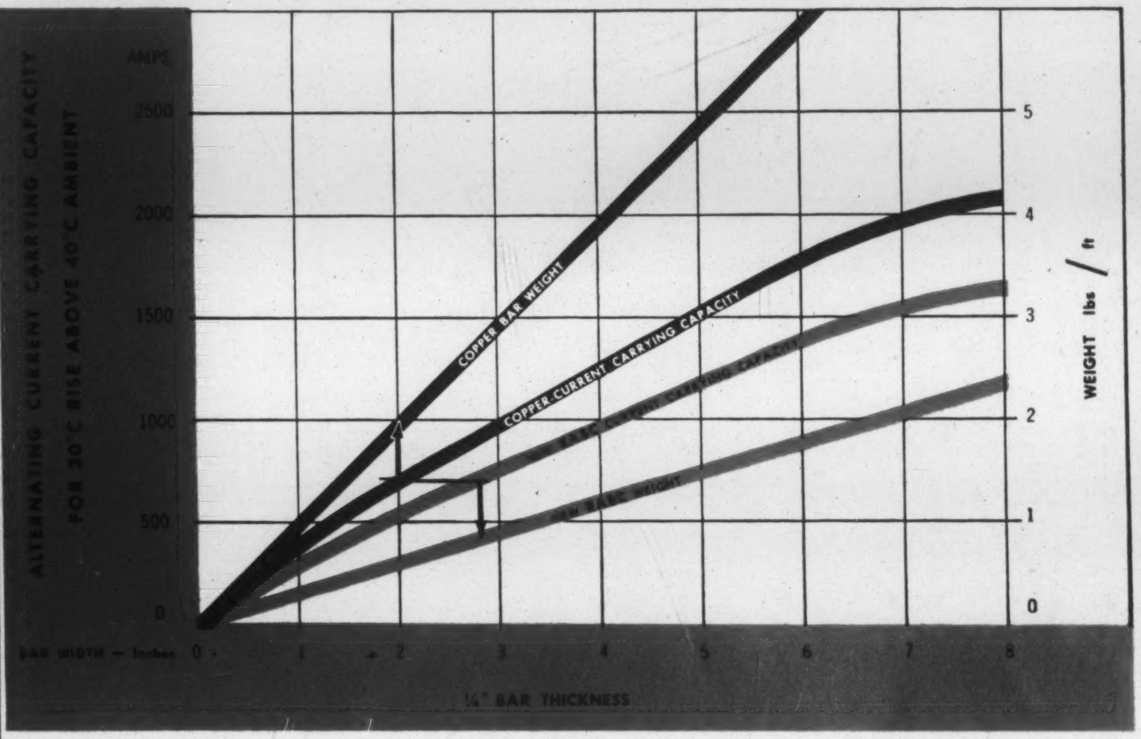
Aluminum Industry Adopts New Alloy Designation System

The Aluminum Association has developed a new system of wrought aluminum alloy designations to supplant various systems previously used. The new system which overcomes inadequacies of the old systems became effective on October first.

To speed transition from the old to the new standard designations the Reynolds Metals Company is offering a simplified conversion chart. Two sizes of the chart are available, one 17″ x 22″ is read easily when wall hung, the other is 8½″ x 11″ for use at desk or drawing board. Both old to new and new to old conversions are shown.

Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky for your free copy of either size chart.

Reynolds Aluminum Development Increases Bus Conductor Strength; Maintains High Conductivity



A new Reynolds development, especially for bus conductor applications, provides greater strength with very little effect on electrical conductivity. An example from the chart above shows why this new material is just what the electrical industry ordered. A current load of 700 amperes requires a copper bar 2″ x ¼″ weighing just under 2 pounds per foot; new RABC (Reynolds Aluminum Bus Conductor) carries the same load with a 2.8″ x ¼″ bar weighing only 4/5 pound per foot. The result is a 60% saving in weight.

New Flexibility in Sizes and Shapes

In addition to providing greater strength advantages RABC is available in an unlimited range of sizes and shapes that permit designing to the minimum amount of metal needed for the current carrying job. It is no longer necessary to specify oversize conductors because of intermediate size limitations. The result is a material cost as low as or lower than for any previous aluminum bus conductor.

Many Cost Advantages

All of the basic advantages of aluminum bus conductor, of course, still hold true. More conductivity per dollar. Long range availability. Excellent resistance to corrosion. And, lighter weight which permits faster, easier handling and saves on installation time and labor costs.

ALUMINUM vs. COPPER BUS CONDUCTOR MATERIALS

PROPERTIES	COPPER	ALUMINUM EC-H17	 RABC
Tensile Strength (psi)	33,000 to 37,500	17,000	29,000*
Yield Strength (psi)	Not Specified	15,000	25,000*
Electrical Conductivity % IACS	98%	61%	55%*
Current Carrying Capacity†	100%	82%	79%
Resistivity @ 20°C (microhms, sq in./ft)	8.31	13.36	14.82
Modulus of Elasticity (lb/in.^{2})	16×10^6	10×10^6	10×10^6
Density (lb/in.^{3})	.322	.09765	.09765
Temp. Coeff. of Resistance (% per °C @ 20°C)	.393	.403	..360

*Guaranteed minimum. †For given temperature rise and same cross section

Send for new descriptive literature on Reynolds Aluminum Bus Conductor and an index of other Reynolds Literature. Write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Kentucky.

300,000 Volts Plus Is Normal Load for Big Reynolds ACSR

Reynolds Metals Company recently fabricated a special order of Aluminum Cable Steel Reinforced (ACSR) as large as any cable yet made for overhead service in this country. This cable has an outside diameter of 1.76 inches and will be used in a 300,000 volt power system. This is a dramatic example of the advantages resulting from the light weight and electrical conductivity of Reynolds Aluminum.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

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(Continued From Preceding Page)

Fluted Aluminum Tubing Ideal for Decorative Applications

Exceptionally beautiful effects in the construction of furniture and architectural decoration are being obtained through the use of tubular, fluted extrusions of 6063-T6 Reynolds Aluminum. They can also be used in making outdoor clothes driers and poles, umbrella and vacuum cleaner handles, display racks, clothes trees, ladder rungs and many other useful items. Ladder rungs of this material, for example, have a safer, nonslipping surface.

The new fluted aluminum tubing has an ultimate strength of 32,000 psi, a yield of 25,000 psi and 8% elongation. Data on standard sizes are given below.

Standard Tube Sizes*	Nominal Weight lb/100 ft	Minimum Inside Bend Radii	
		Machine Bending With Mandrel	Machine Bending Without Mandrel
3/4" x .050" Wall	12.7	1 13/16"	1 5/8"
7/8" x .050" Wall	13.7	2 7/16"	2 3/16"
1" x .050" Wall	16.0	3 1/8"	2 13/16"
1" x .0625" Wall	20.0	2 3/8"	2 1/16"

*Other sizes available on special inquiry

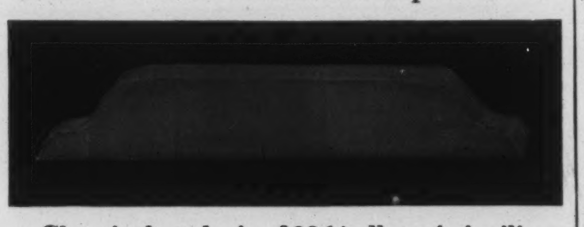
Smooth surface drawn aluminum furniture tubing for other than fluted finishes, of course, continues to be available in 6063-T831 and 6063-T832 alloys and tempers, in 3/4", 7/8" and 1" sizes, with .049" through .065" wall thicknesses. For more complete information write Reynolds Metals Company, 2576 South Third St., Louisville 1, Kentucky.

Reynolds New Master Alloy Aluminum Pigs Cut Foundry Costs

A new concept of reduction pot practices has resulted in the production of two new master alloy aluminum pigs at regular pig prices.

Both new pigs, designated as 2364 and 2393, have been added to the full line offered by the Reynolds Metals Company. Their use in foundries provides improved production control and fewer rejected castings.

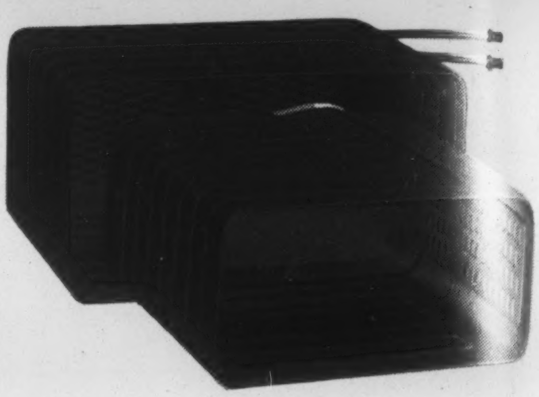
Available in the 50 pound size, these new master alloy pigs provide more uniform analysis through simple blending with secondary metals to control undesirable impurities.



Chemical analysis of 2364 alloy pig is silicon 6%, copper 4%, nominal iron and balance aluminum. 2393 alloy pig has a chemical analysis of silicon 9%, copper 3½%, iron ¾%, balance aluminum. Complete information on these and the family of aluminum pig and ingot products by Reynolds is available from the Reynolds office or Pig and Ingot Distributor listed under "Aluminum" in your classified telephone directory. Or write direct.

Roll Bonded Aluminum Sheet Now Produced by Reynolds for Refrigeration Industry

Reynolds roll bonded aluminum sheet is two sheets of aluminum metallurgically bonded together. It is an ideal material for refrigerator evaporators, freezer liners and freezer cold plates. In fact, it should be an economical, efficient and practical replacement for all applications involving heat exchanging where tubing fastened to sheet has been used in the past.



Metal ordinarily used for tubing, accumulators and receivers is eliminated. The passageways are inside the sheet. There are no tubes to bend. Welding is minimized. There is no brazing and therefore no flux contamination. Many connecting and assembly operations are eliminated. There is no problem of lost conductivity. Cleaning time and expense are reduced because there are no deep crevices where tubing meets sheet.

Tubing contours smoothly into the sheet. Expansion, radius and bending problems inherent with tubing are eliminated. You can route refrigerants wherever they are needed. Passageways may be flat, oval or round. They can be smaller and can be placed closer together. Additional length adds nothing to the cost. Reynolds roll bonding is strong and compact. Passageways themselves act as stiffening ribs and contribute to the overall sturdiness of the unit.

For more details on Reynolds roll bonded aluminum sheet or for Reynolds engineering assistance on fabricated parts for your particular products, regardless of your industry, contact the Reynolds office listed under "Aluminum" in your classified telephone directory. Write for your free copy of the 20-page brochure, "Aluminum Appliance Parts" and the 24-page "Catalog of Facilities" to Reynolds Aluminum Fabricating Service, 2065 South Ninth Street, Louisville 1, Kentucky.

New Edition of "Aluminum Data" Offers Valuable Information to Aluminum Users

Reynolds Metals Company has just released the 1954 edition of the "Aluminum Data Book". It contains 220 pages of detailed information on the properties and characteristics of aluminum and is considered the most complete and up-to-date technical information on aluminum now available.

The ALUMINUM DATA BOOK
ALUMINUM ALLOYS AND MILL PRODUCTS
REYNOLDS METALS COMPANY

Text and tabular information on physical, chemical and mechanical properties of aluminum as well as data on tolerance, weight, fabricating characteristics, etc. have been expanded.

Entirely new information is presented on radioactive isotopes of aluminum, thermal neutron absorption cross sections for various metals, as well as the elements found in commercial aluminum alloys.

Other new material includes a section on "Availability" showing manufacturing limits on standard aluminum mill products and giving details on aluminum powders, pastes and chemicals. A section is devoted to the new alloy designation system just adopted by The Aluminum Association. New and old system equivalent tables are shown.

Single copies of the book are available to engineers, designers, technical men, instructors and executives without charge when request is made on a business letterhead. Address requests to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

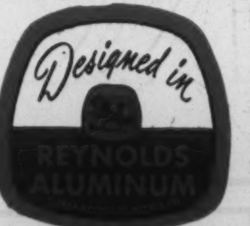
Reynolds Begins $2,585,000 Expansion of Sheffield, Alabama Sheet Mill

New melting equipment capable of producing about 90,000,000 pounds of aluminum annually is being installed as the first step in a broad expansion program planned for Reynolds sheet mill in Sheffield, Alabama. This will permit Reynolds to give better delivery to the ever-expanding market for aluminum sheet. Additional annealing facilities consisting of four new furnaces, each with a capacity for 120,000 pounds of aluminum coils are also being added to the plant.

A number of new buildings will be required to house the new melting and annealing facilities.

Fabricators Benefit from Reynolds Design Seal Program

More and more manufacturers are participating in the "Designed in Reynolds Aluminum" Seal program. Applied to the manufacturers' products it tells a stronger quality story at point-of-sale. Reynolds national magazine advertising and outstanding "Mister Peepers" TV show are benefiting Seal program participants.



For details on how your company can qualify for the Seal, write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.

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WORKABILITY

is important

SPECIFY BISHOP STAINLESS STEEL TUBING (.008″ TO 1″ O.D.)

Careful metallurgical control is imperative to assure the attainment of the desired properties in stainless steel tubing, particularly workability. Bishop assures this by inspecting chemically, metallurgically and visually each requirement against customer specification.

J. Bishop & Company, the first American company to successfully draw small diameter stainless steel tubing specializes in small diameter tubing (.008″-1″ O.D.). Bishop's 25 years' experience in stainless steel tubing and 113 years' experience fabricating precious metals are your assurance of precision fabrication and quality craftsmanship.

The next time, particularly if workability is important, specify Bishop stainless steel tubing and be sure. Catalog on request.

If you buy stainless steel fabricated tubular parts, or fabricate parts yourself from stainless tubing, investigate Bishop's cost-reducing "under one roof" drawing and fabricating facilities. You'll save more.

JB

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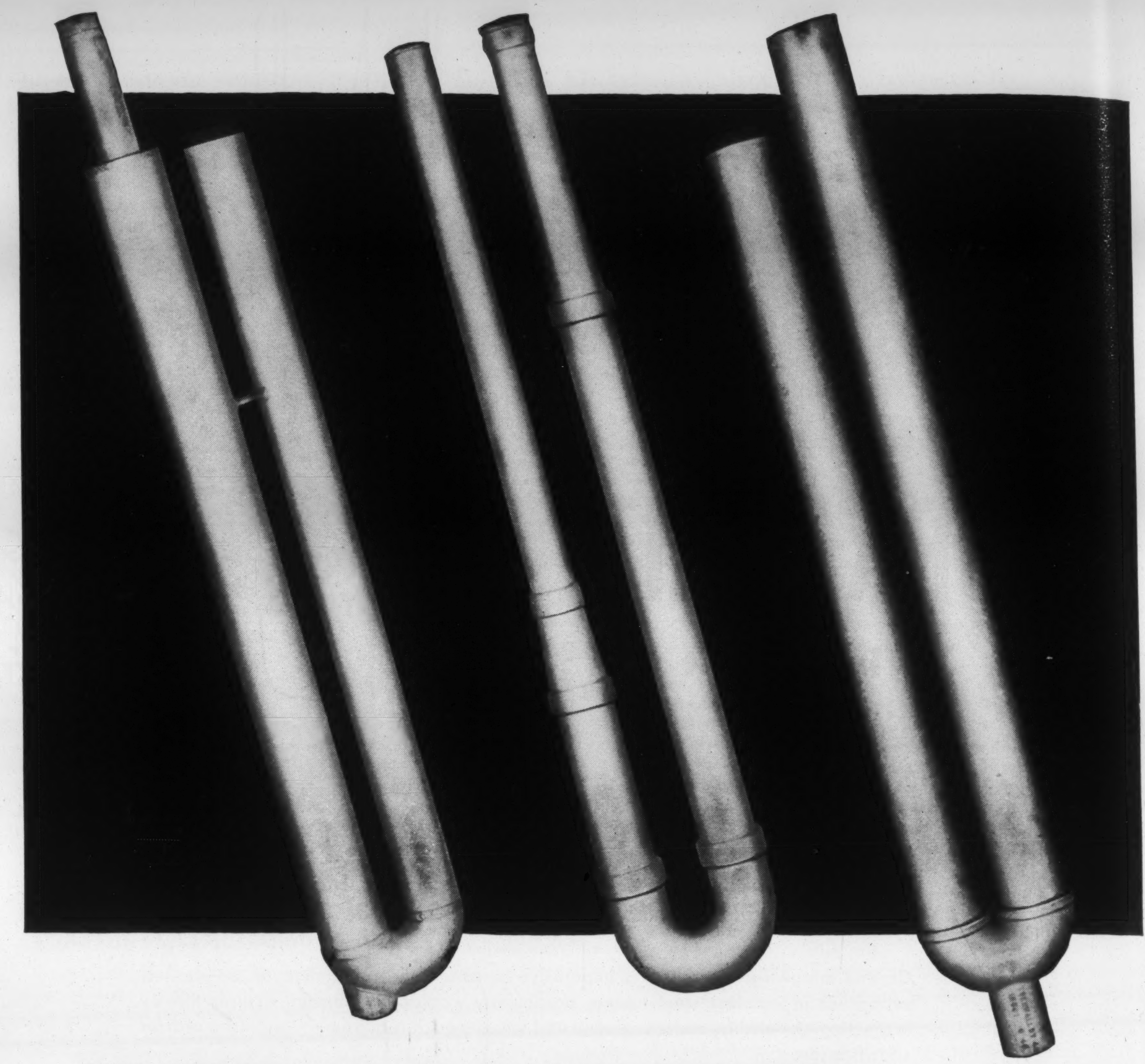

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All components are produced in suitable analyses under close metallurgical supervision, and with X-ray control. The straight tube sections are centrifugally cast in such a way that wall thickness is uniform throughout; i. e., inside diameter and outside diameter are concentric, and thickness is the same the full length of the tube. All finished assemblies are pressure-tested before shipment to insure freedom from leakage. As a result, you are assured of radiant tube assemblies that last longer without cracking, warping or sagging.

Whatever your needs in radiant tube assemblies or other heat-treating equipment—you'll get more operating economy from high heat-resistant Thermalloy castings. Let us know your requirements. Call your nearest Electro-Alloys engineer or write Electro-Alloys Division, 5001 Taylor Street, Elyria, Ohio.

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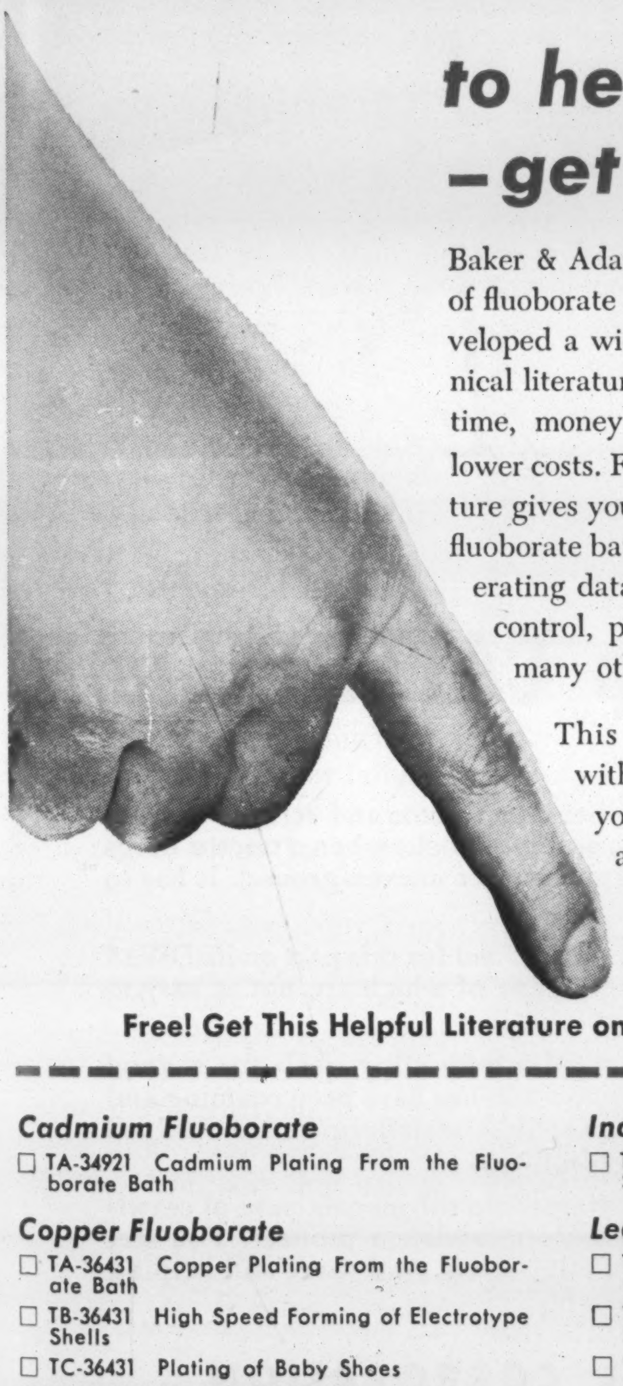
Now–Important New Information on B&A® METAL FLUOBORATES



to help you save time, money –get better plating results

Baker & Adamson, the pioneer producer of fluoborate solutions for plating, has developed a wide range of important technical literature designed to help you save time, money and get higher output at lower costs. Free for the asking, this literature gives you full details on plating from fluoborate baths. Included is complete operating data covering bath composition, control, plating rates, etc., as well as many other useful facts.

This exclusive data on plating with B&A Fluoborates come to you through original research and development at General Chemical's Technical Service Laboratory in Edgewater, New Jersey. In this fully equipped laboratory our staff of plating specialists works constantly to develop new uses; improve old ones. The benefits of this extensive experience are available to you through the bulletins listed below.

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Cadmium Fluoborate

☐ TA-34921 Cadmium Plating From the Fluoborate Bath

Copper Fluoborate

☐ TA-36431 Copper Plating From the Fluoborate Bath
☐ TB-36431 High Speed Forming of Electrotype Shells
☐ TC-36431 Plating of Baby Shoes
☐ TD-36431 Plating of Plastics
☐ TE-36431 Plating of Rotogravure Cylinders
☐ TF-36431 Manufacture of Sound Records
☐ TG-36431 Plating of Printed Circuits
☐ RA-36431 "Copper Plating From Fluoborate Solutions," reprinted from *"The Monthly Review," official organ of the American Electroplaters Society, September, 1946.*
☐ RB-36431 "Copper Fluoborate Plating Experiences," reprinted from *"The Electroplaters and Stereotypers Magazine," June, 1953.*

Ferrous Fluoborate

☐ TA-37641 Iron Plating of Stereotypes
☐ RA-37641 "Iron Plating Curved Stereotypes From a Fluoborate Bath," reprinted from *"The Electrotypers & Stereotypers Magazine," July, 1952.*

Fluoboric Acid

☐ TA-30691 Applications in Metal Finishing

Indium Fluoborate

☐ TA-37991 Indium Plating From Fluoborate Solutions

Lead Fluoborate

☐ TA-38351 Lead Plating From the Fluoborate Bath
☐ TB-38351 *Lead-Tin Alloy Plating From the Fluoborate Bath
☐ TC-38351 *Lead-Tin Alloy Plating in Electrotyping and Other Applications
☐ RA-38351 *"Metal Coatings Improve Solder Flow on Steel and Brass," reprinted from *"Materials & Methods," May, 1949.*
☐ RB-38351 *"Solderability of Lead-Tin Alloy Plating," reprinted from *"Iron Age," December 8, 1949.*

Nickel Fluoborate

☐ TA-40221 Barrel Plating
☐ TB-40221 Plating Stereotypes
☐ TC-40221 Plating Upon Aluminum
☐ RA-40221 "Barrel Plating with Nickel Fluoborate," reprinted from *"Plating," October, 1950.*
☐ RB-40221 "High Speed Nickel Plating of Curved Stereotypes," reprinted from *"Electrotypers & Stereotypers Bulletin, March, 1950.*
☐ RC-40221 "Nickel Plating From Fluoborate Solution," reprinted from *"Plating," December, 1950.*

Tin Fluoborate

☐ TA-43441 Tin Plating From the Fluoborate Bath
☐ TB-43441 Plating of Electrotype Shells
☐ TC-43441 Electrotinning of Copper Wire.

See Also Articles Marked*.

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MM-12

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Right: This "king bolt," made of Republic Alloy Steel, serves as hitch between tractor and trailer. Below: Caterpillar Diesel DW15 Tractor and No. 15 Scraper working on road job in Colorado.

How Republic Alloy Steels Help CATERPILLAR®

Take the "king bolt." It's the link between tractor and scraper or wagon. It takes all the pull, the bumps, and the shocks when a tractor drags earth-moving or other heavy equipment over uneven ground. It has to be tough.

Caterpillar uses a specific Republic Alloy Steel for this part on its DW15 tractor. And for other parts as well, many of which are not as easy to spot. But all of which are important.

Republic has been supplying Caterpillar with alloy steels for a good portion of the 50 years that track-type machines have been roaming and moving the earth. More than this, Republic metallurgists have helped Caterpillar use these steels to best advantage.

This year is Caterpillar's 50th Anniversary in the manufacture of crawler tractors. And Republic is glad to congratulate a pioneer. You see, Republic pioneered the wide use of alloy steels. And we're still helping manufacturers use these steels profitably.

REPUBLIC STEEL CORPORATION
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Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Bars, Wire, Pig Iron, Steel and Plastic Pipe, Bolts and Nuts, Tubing

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DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company DECEMBER 1954

Insulator of KEL-F® Plastic Doubles as Vital Structural Part in Severe 250°F Water-Immersion Service

Perfect electrical insulation and maintenance of critical spacing of electrodes are provided by this spacer of KEL-F polymer plastic. Even under constant immersion in water at 250°F, insulation remains high, precision tolerances and dimensions of the spacer-insulator are maintained.

Excellent mechanical properties of this fluorocarbon plastic dielectric under extremes of temperature and stress permit the critical spacer to be used under heavy spring loading without deformation or failure. Accurately machined grooves in the plastic hold O rings to prevent liquid leakage.

McNab Incorporated, New York City, machines the spacers from rod extruded from unplasticized KEL-F polymer by the Resistoflex Corporation, Belleville, N. J. Spacers are used in special conductivity cell-valve units manufactured by the McNab company for use in marine and industrial installations producing potable water.

For further information ask for Application Report E-131

Prosthetic Eye Implants are Permanent—Non-Irritating to Living Tissue, They Retain Shape Indefinitely

Elimination of the necessity for periodic removal of prosthetic eye implants for replacement or "re-sizing" is the major advantage claimed for implants made from KEL-F polymer plastic. Once "fitted" to the individual eye socket, the implant retains its original size and shape, does not shrink or swell to cause pain to the wearer. The plastic's heat and moisture resistance allow it to be steam sterilized.

Since the fluorocarbon plastic is chemically inert, it does not cause irritation to adjacent sensitive tissues.

The plastic implant, known as the "Allen", is custom made from KEL-F polymer Grade 270 by Precision-Cosmet Co., Inc. of Minneapolis, Minn.

For further information ask for Application Report P-103

(SEE REVERSE SIDE)

® R stered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.

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CHLORO
ETHYLENE
POLYMERS

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FLUORO
CHLORO
CARBON
PLASTIC

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COATINGS

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WAXES
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DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE

KEL-F® Polymer Teamed With High-Alloy Steel in New Centrifugal Pump For Corrosives, Sanitary Use

A KEL-F plastic O ring is used with Type 20 stainless steel and heat-resistant glass to create a new, low-cost centrifugal pump with extreme corrosion resistance and ready flow visibility.

The KEL-F plastic seal remains resilient, is unaffected by practically all known chemical agents over a wide range of temperatures and prevents damage to the glass cover plate. Unique physical characteristics of the plastic permit ready dismantling of pump and re-use of the O ring without loss of sealing effectiveness.

The new pumps, built by the Eco Engineering Company, Newark, N. J., use precision O rings molded of plasticized KEL-F polymer Grade 300 P-25 by Young Development Laboratories, Inc., custom molders of Rocky Hill, N.J.

For further information ask for Application Report C-121

Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

Auburn Button Works, Inc.
Auburn, N. Y.
Injection molding

Bacon Industries, Inc.
Watertown, Mass.
Compression & transfer molding
Gaskets & O rings

Elco Corporation
Philadelphia, Pa.
Injection molding
Electronic tube sockets

Electronic Mechanics Inc.
Clifton, N. J.
Extrusion, injection, compression & transfer molding
Forming
Rod, tube & sheet
Coil forms & tube sockets
Diaphragms & gaskets

A. Gusmer, Inc.
Stalpic Division
Woodbridge, N. J.
Corrosion control
Dispersion application

Recent Significant KEL-F Polymer Developments . . .

Lip seals for liquid oxygen and other liquefied gas equipment operating at low temperatures are molded now of KEL-F plastic. Resiliency at subzero temperatures, dimensional stability and chemical inertness overcome shortcomings of other gasket and sealing materials used.

Liquid level gauges now have their glasses protected by a thin sheet of KEL-F plastic. Remaining transparent indefinitely in spite of contact with highly corrosive chemicals such as HF, the plastic sheets act as their own gaskets.

Miniature coil forms are molded of KEL-F plastic for use in electronic devices operating at elevated temperatures. Types include special models with metal inserts.

Quality test for use by the manufacturer of trifluorochloroethylene polymer parts (the "Z.S.T." test) has been developed and field-tested by Kellogg. Test is simple, requires no special training. Equipment is automatic, eliminates the human error factor in test results.

OFF THE PRESS . . .

Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

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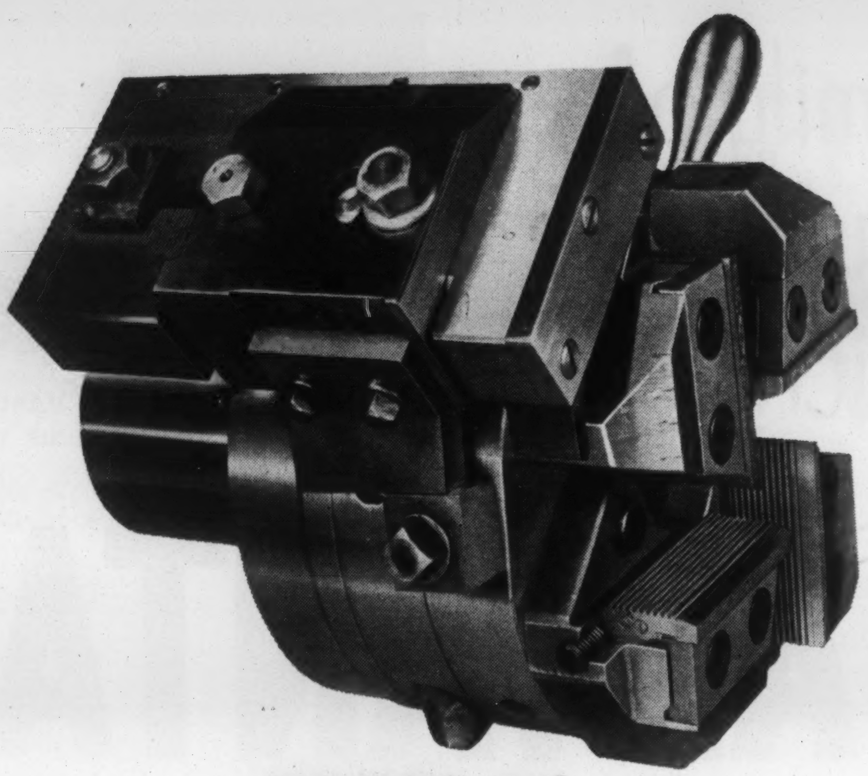
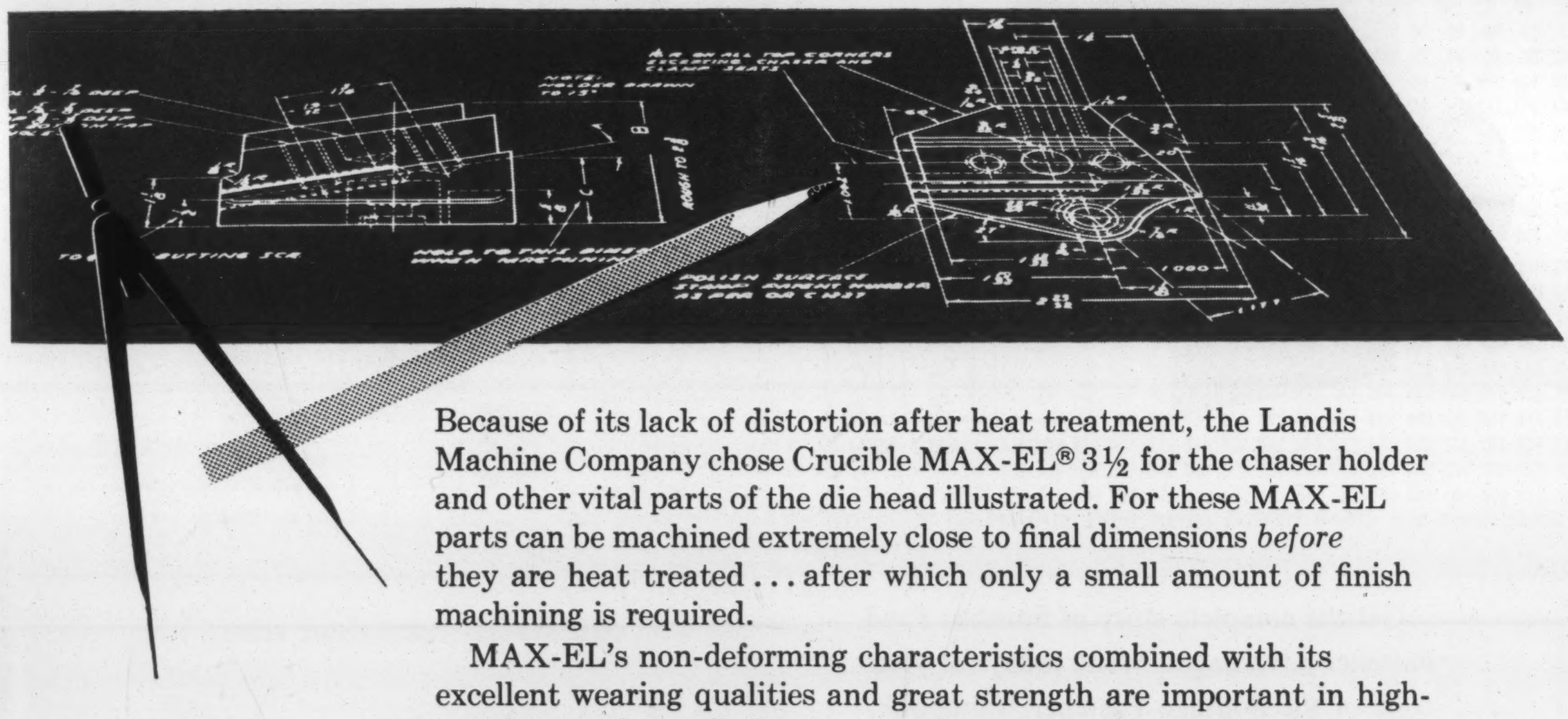


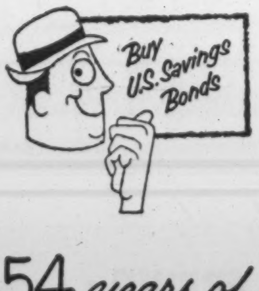
Non-deforming **MAX-EL** alloy steel parts require minimum finish machining



Because of its lack of distortion after heat treatment, the Landis Machine Company chose Crucible MAX-EL® 3½ for the chaser holder and other vital parts of the die head illustrated. For these MAX-EL parts can be machined extremely close to final dimensions *before* they are heat treated . . . after which only a small amount of finish machining is required.

MAX-EL's non-deforming characteristics combined with its excellent wearing qualities and great strength are important in high-speed turret lathe die heads . . . and in many other applications.

Your shop will benefit, too, from the ease of machining, freedom from distortion, superior quality and longer tool life you get with MAX-EL. To start taking advantage of MAX-EL *now, call Crucible.*



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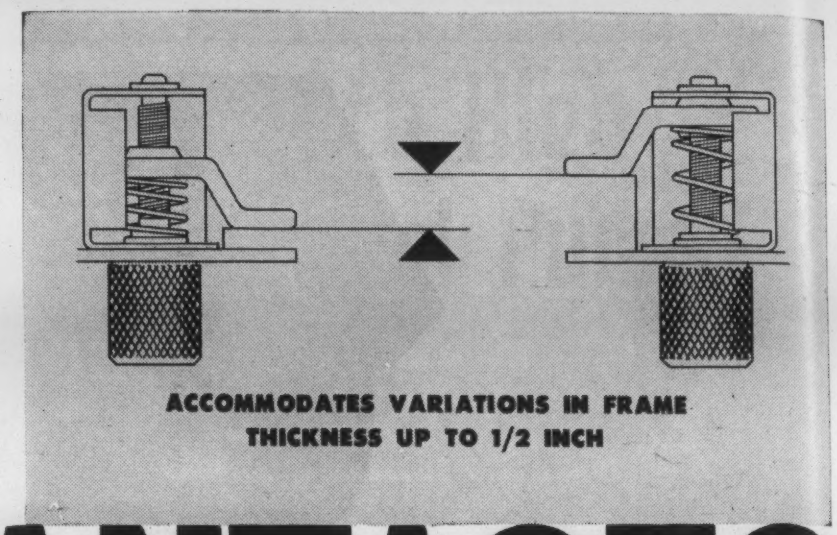
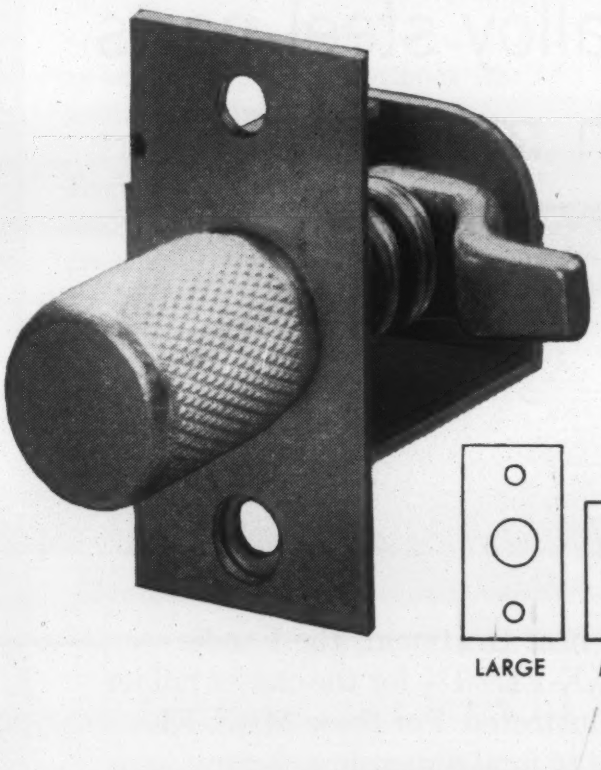
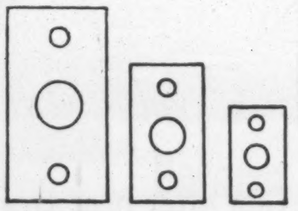
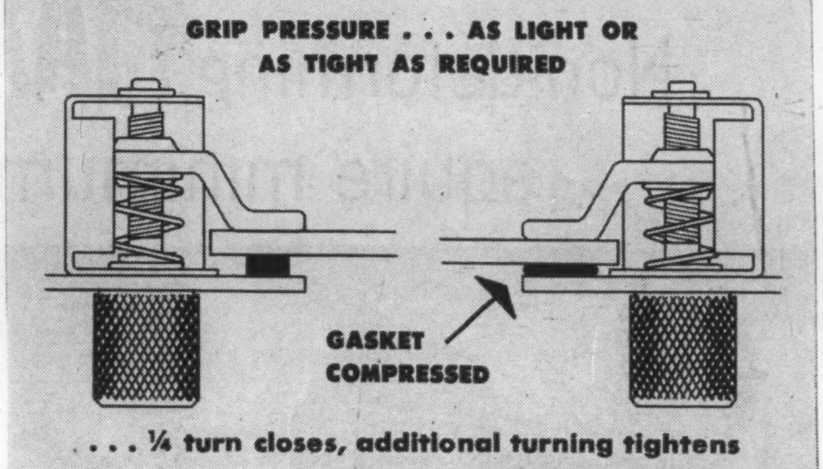
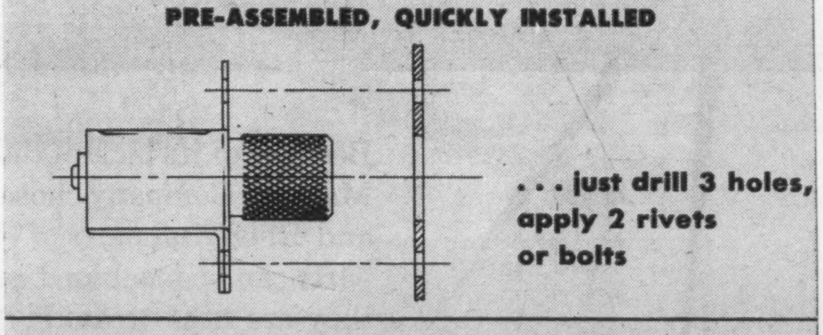

ACCOMMODATES VARIATIONS IN FRAME THICKNESS UP TO 1/2 INCH



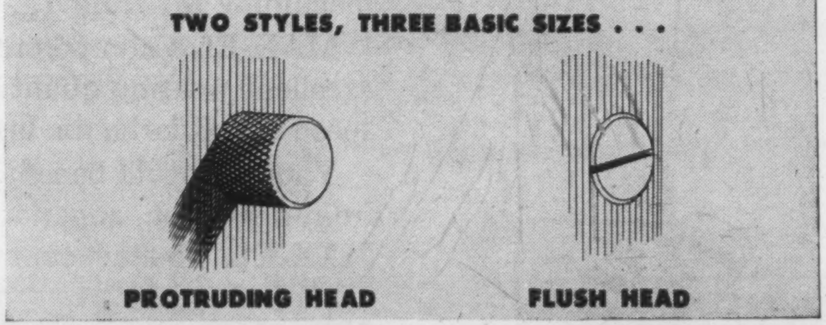



GRIP PRESSURE . . . AS LIGHT OR AS TIGHT AS REQUIRED

. . . ¼ turn closes, additional turning tightens


PRE-ASSEMBLED, QUICKLY INSTALLED

. . . just drill 3 holes, apply 2 rivets or bolts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Get the complete story of Southco Pawl Fastener advantages. Write today for your copy of the Southco Fastener Handbook. Southco Division, South Chester Corporation, 234 Industrial Highway, Lester, Pa.

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Closed-Cell Sponge Rubber. Automotive Rubber Co., Inc., 4 pp, ill. Describes insulating and shock-absorbent synthetic rubber. Specifications and chemical resistance table. (1)

Vinyl Butyral Resins. Bakelite Co., Div. of Union Carbide & Carbon Co., 27 pp, Technical Release No. 11. Resin with high impact strength and adhesion properties for wash primers or metal conditioners, wood and metal finishes, adhesives and cloth coatings. (2)

Custom and Standard High Alloys. Cannon-Muskegon Corp., 4 pp, ill. Ferrous and nonferrous alloys for castings, extrusions and forgings. For remelt or direct use. (3)

Teflon. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 60 pp, ill. Definitive handbook on tetrafluoroethylene resins. Thorough treatment of history, characteristics, manufacture, compositions, uses and properties of all grades of resin. Analyzes processing techniques for molding, regular- and ram-extrusion, calendering, casting, dip coating and impregnation. Charts, graphs and bibliography. (4)

Bright Nickel. Harshaw Chemical Co., 4 pp, ill. Process combines brightness and good ductility for applications where little or no basis-metal finishing is done prior to plating. (5)

Nickel-Chromium Steels. International Nickel Co., Inc., 8 pp, No. NS-5. Charts on composition, heat treatment, transformation characteristics and mechanical properties of AISI and SAE nickel-chromium steels. (6)

Powder Metallurgy. Keystone Carbon Co., 6 pp, folder. Describes company's powdered metal products and facilities for production. (7)

Lithium Metals and Compounds. Lithium Corp. of America. Data sheets on properties and uses of lithium metal and organic and inorganic lithium compounds for metal treatment, ceramic modifications, welding, etc. (8)

Magnetic Iron Powders. Magnetic Powders, Inc., 8 pp, ill, No. 354. Composition and electronic applications of various types of magnetic powders. (9)

Industrial Plastics. Joseph T. Ryerson & Sons, Inc., 16 pp, ill. Data on the manufacture, grades, properties, fabrication and use of laminated plastic sheets, tubes, rods and special shapes. (10)

Polishing and Buffing Machines. Acme Mfg. Co., 12 pp, ill. Rotary automatic machines for polishing and buffing, de-burring, wire brushing and micro-finishing. (11)

Metal Stitching. Acme Steel Co., 12 pp, ill. Technique for metal-to-metal and nonmetallic-to-metal fastening, using wire stitching. Specifications and case histories. (12)

Arc Welding. Air Reduction Co., Inc., 16 pp, ill, No. 9. Argon and helium inert-gas arc-welding process that is oxidation-free and eliminates flux. (13)

Hot Extrusions. Allegheny Ludlum Steel Corp., 4 pp, ill, No. SS-41. Hot extruded forms of stainless, tool steel and high temperature alloys. Stresses low scrap, minimum machining, low die cost for special sections. (14)

High Voltage Conductor. Aluminum Co. of America, 16 pp, ill. "Alcoa Expanded ACSR". New conductor cable for 300 KV and above. Describes cable construction, line erection techniques and special accessories. (15)

Wear Resistant Materials. American Brake Shoe Co., 48 pp, ill. Catalog of representative products; castings, bearing materials, forgings, sintered metals and industrial equipment. (16)

Aluminum Protection. American Chemical Paint Co., 4 pp. How to protect unpainted aluminum with "Alodine" No. 1200, a corrosion-resistant coating providing a durable paint bond. (17)

Casting Impregnation. American Metaseal Mfg. Corp., 8 pp, ill. Equipment and impregnants for batch impregnation of porous castings. Properties and applications listed. (18)

Titanium Foil. American Silver Co., Inc., Technical Data Sheet No. 100. Thin gaged, commercially pure titanium foil rolled to close tolerance. Includes tolerance chart, mill limits, mechanical and electrical properties, and suggested applications. (19)

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You'd have to go to laminates to get a lower rate of moisture pick-up. Flexural strength is greatly improved. Appearance-wise, coated DUROIDS are slick, smooth and shiny.

One user, interested in improved arc resistance for a low voltage application, tested DUROID 800 with an epoxy coating. Result: our material showed no sign of failure after a test period 2000 cycles longer than the point at which the next best material (fiber board on laminated phenolic) had broken down.

We are equipped to coat our DUROIDS to your specific requirements, using a wide range of surfaces, including epoxies, vinyls, alkyds, etc. Name your need — coated DUROIDS may be the best and lowest cost solution.

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PRODUCTS

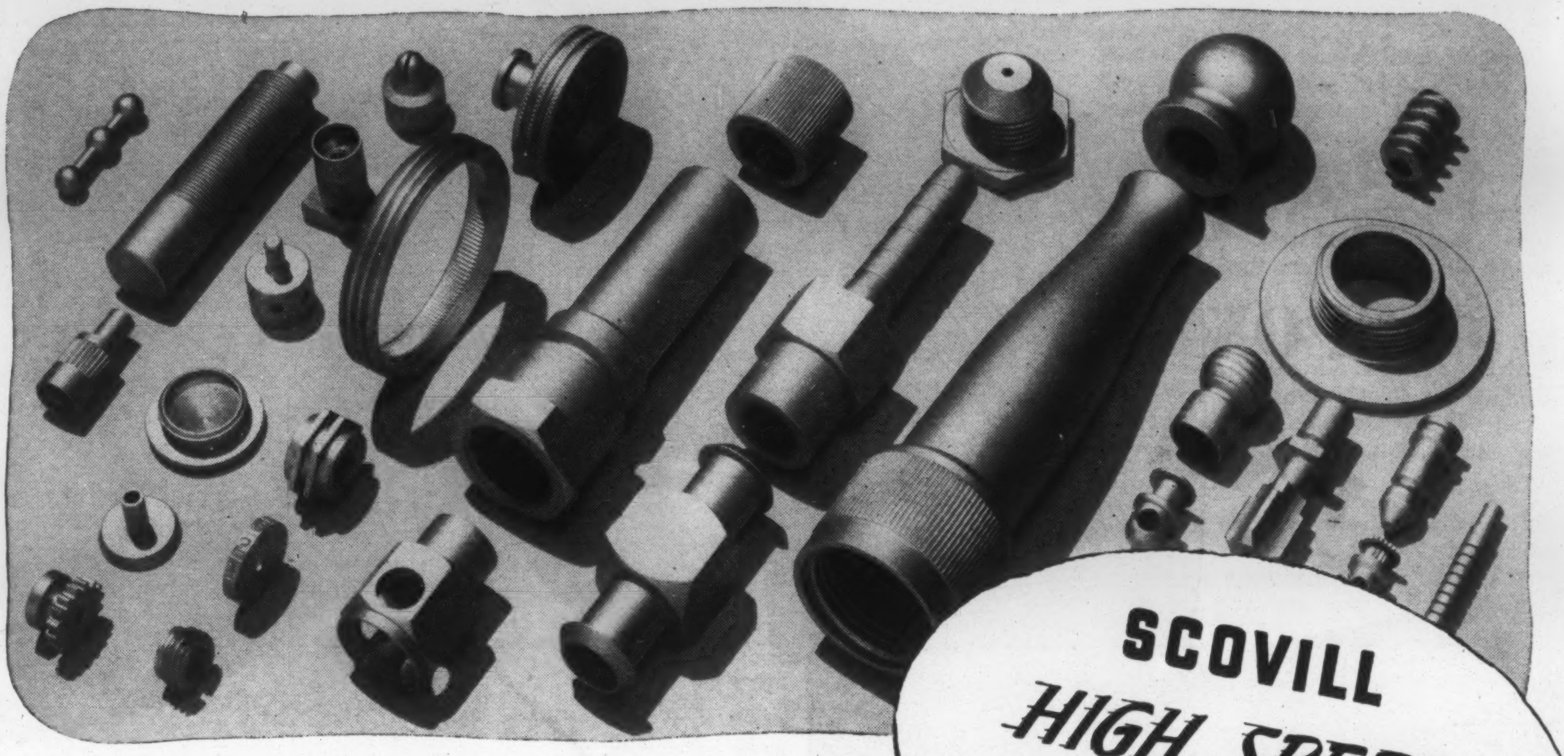
DUROIDS — for Gaskets, Filters, Electronic Devices, etc.
ELECTRICAL INSULATION — for Motors, Transformers, Generators, etc.
SHOE MATERIALS — for Counters, Midsoles, Liners, etc.
PLASTICS — Special Purpose Molding Compounds and Laminates

SERVICES

Research, Development, and Engineering of New Materials, Parts and Products • Fabricating, Combining, Coating, & Embossing

• **For more information, turn to Reader Service Card, Circle No. 367**

Make SCOVILL MILL PRODUCTS a partner in your search for more efficient SCREW MACHINE OPERATION



When products like these are made from . . .

SCOVILL
HIGH SPEED
BRASS ROD
(free-cutting)

You Can SELL the Difference . . .

Again and again we have been told that Scovill HIGH SPEED Brass Rod (free-cutting) helps approach realization of seven prime objectives:

- Maximum number of highest quality pieces per minute.
- Maintenance of close tolerances.
- Sharp, free-running threads.
- Uniform and short chip breakage.
- Excellent tool life.
- Thin cut-offs.
- Smooth, clean surfaces.

There are many technical reasons for the DIFFERENCE in Scovill HIGH SPEED Brass Rod. It is, for example, hot extruded from exceptionally uniform billets produced by the Scovill-pioneered Continuous Casting Process. Special methods are used to obtain correct temper draw. No matter how much of this fine rod you use, you will find dependably uniform chemical analysis and uniform temper from rod to rod, order to order . . . freedom from extrusion defects . . . smooth, clean burnished surfaces.

Scovill HIGH SPEED Rod is suitable in temper for 99% of screw machine operations, and is stocked for immediate availability at key industry centers. Contact your nearest Scovill Branch Office listed below.

SCOVILL MILL PRODUCTS

BRASS ★ BRONZE ★ NICKEL SILVER ★ ALUMINUM

BOSTON AREA
1116 Great Plain Avenue
Needham 92, Mass.

CHICAGO 51, Illinois
4105 West Chicago Avenue

CINCINNATI 2, Ohio
49 Central Avenue

CLEVELAND 2, Ohio
6516 Detroit Avenue

DETROIT 7, Michigan
6460 Kercheval Avenue

GREENSBORO, North Carolina
1108 East Wendover Avenue

LOS ANGELES 23, California
2627 South Soto Street

NEW YORK 17, New York
Chrysler Building East
161 East 42nd Street

PHILADELPHIA 22, Pennsylvania
1419 North Broad Street

PROVIDENCE 3, Rhode Island
183 Public Street

ROCHESTER 4, New York
Hiram Sibley Building
311 Alexander Street

SAN FRANCISCO 7, California
434 Brannan Street

STURGIS, Michigan
Congress Street

SCOVILL MANUFACTURING COMPANY, WATERBURY 20, CONNECTICUT

9SC54

For more information, turn to Reader Service Card, Circle No. 395

It gets its fuel through 1/4" tubing at pressures up to 1,700 psi

Meet the "Boss of the Crawlers"—Caterpillar Tractor Co.'s new 150 D.B. hp giant that toys with tons of earth, plays marbles with huge boulders, topples trees like tenpins.

Superior Tube supplies metal gullets through which such landscape levelers gulp their fuel.

Through ¼ inch O.D. tubing, diesel fuel is injected to cylinders at pressures up to 1,700 psi. So fuel injection tubing must be clean, have tremendous burst strength and resistance to fatigue. To meet Caterpillar's stringent specifications, Superior selects C-1008 Low Carbon Steel Tubing, draws it to size 250/255'' O.D. x 0575/0675'' I.D., then tests its mechanical properties to the utmost.

Result: heavy wall tubing with Rockwell hardness of B-65 maximum—capable of being cold upset without difficulty and cold formed into loops and bends without excessive springback. Bore is of uniform diameter, smooth and specially cleaned, and fracture testing and inspection at 15 power magnification assure freedom from cracks or seams of a depth greater than 5/1000 of an inch!

Scrupulous care in preparing, drawing and testing other grades of alloy and stainless Superior tubing makes them first choice for lubricating and cooling lines, governor shafts, valve spacers and valve push rods. One of our more than 55 analyses should be *your* choice, too, if you need trustworthy tubing and special help in adapting it to your use. Write us about your current tubing problem. We'll send you complete information and the appropriate catalog or technical bulletin by return mail. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Round and Shaped Tubing Available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium.

All analyses .010" to ⅝" O.D. Certain analyses in light walls up to 2½" O.D.

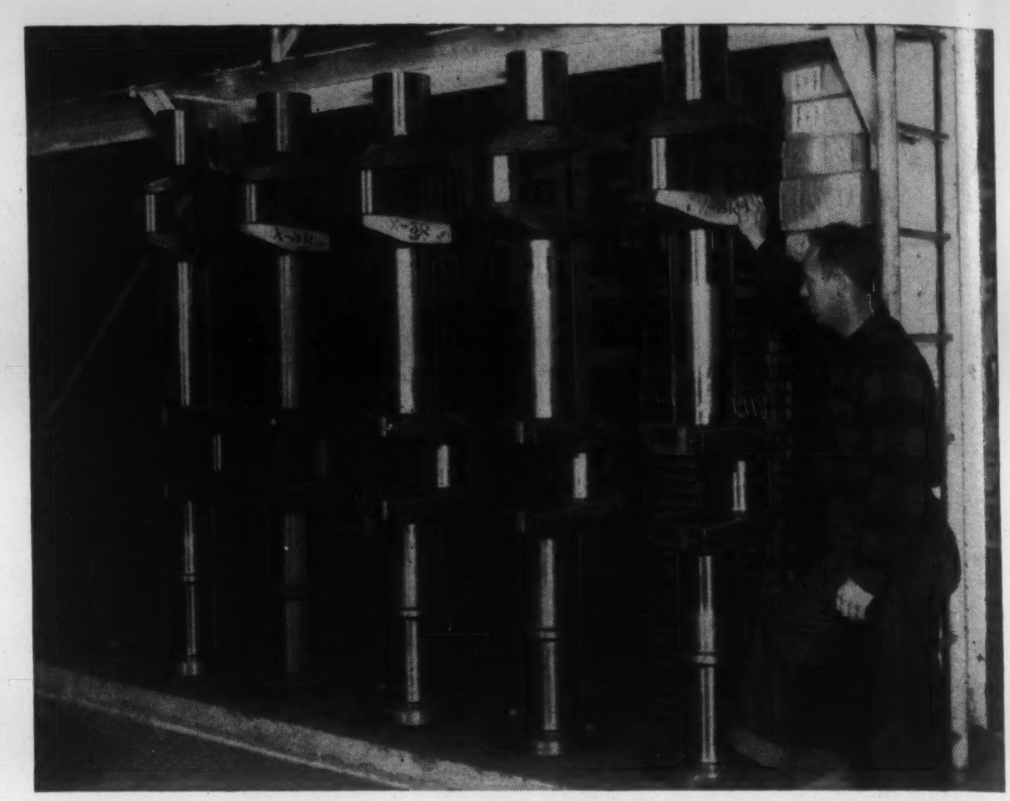
Superior Tube

The big name in small tubing

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

For more information, turn to Reader Service Card, Circle No. 326

Ductile Iron Crankshafts cast at The Cooper-Bessemer Corporation's Mount Vernon, Ohio, foundry and machined at its plant in Grove City, Pa., for GMX-4 engines. The first of this model equipped with a ductile iron shaft was shipped in June, 1953. Cooper-Bessemer initiated development work on high test irons for crankshafts in 1935. Some mechanical properties of ductile iron, compared with those of forged steel . . . traditionally used for crankshafts . . . are shown below.



HIGH
Mechanical Properties, Wear Resistance and Castability make
Ductile Iron an Ideal Crankshaft Material

Comparative Properties

	Ductile Iron	Forged Steel
Tensile Strength	79,200 psi	80,100 psi.
Endurance Limit (Smooth bar)	31,500 "	35,000 "
Endurance Limit (Notched bar)	20,750 "	17,800 "
Modulus of Elasticity	22,600,000	29,000,000
Brinell Hardness	220	170

Wouldn't you rather *cast* a crankshaft than block forge it?

Wouldn't your costs tumble for every unit with bearings cored out, counter-weights molded on, and the entire piece cast within tolerances that reduce machining to a minimum?

And wouldn't the excellent castability, toughness, stiffness and machinability of ductile iron bring you advantages like those brought to Cooper-Bessemer?

Glance at the tabulation. You'll see a few reasons why Cooper-Bessemer concluded that ductile iron provides the best combination of properties offered by any material they have tested for crankshafts.

The damping capacity of ductile iron is excellent . . . less than that of gray iron, but far superior to steel. Especially valuable in crankshafts is the relatively high "notched endurance limit" of ductile iron. And another outstanding property is its resistance to mechanical wear... under lubricated or non-lubricated conditions.

Combining the *process advantages* of cast iron and the *product advantages* of cast steel, ductile iron has, actually, many applications.

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

Please send me a list of publications on: DUCTILE IRON.

Name________________________ Title________________
Company____
Address____
City________________________ State________________

THE INTERNATIONAL NICKEL COMPANY, INC. **67 WALL STREET NEW YORK 5, N. Y**

For more information, turn to Reader Service Card, Circle No. 307

FAIRPRENE®

synthetic elastic compositions

MATERIAL ENGINEERING SERVICE

SHEET STOCKS • COATED FABRICS • INDUSTRIAL ADHESIVES

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Now Du Pont is working with major companies to develop silicone-rubber FAIRPRENE compositions

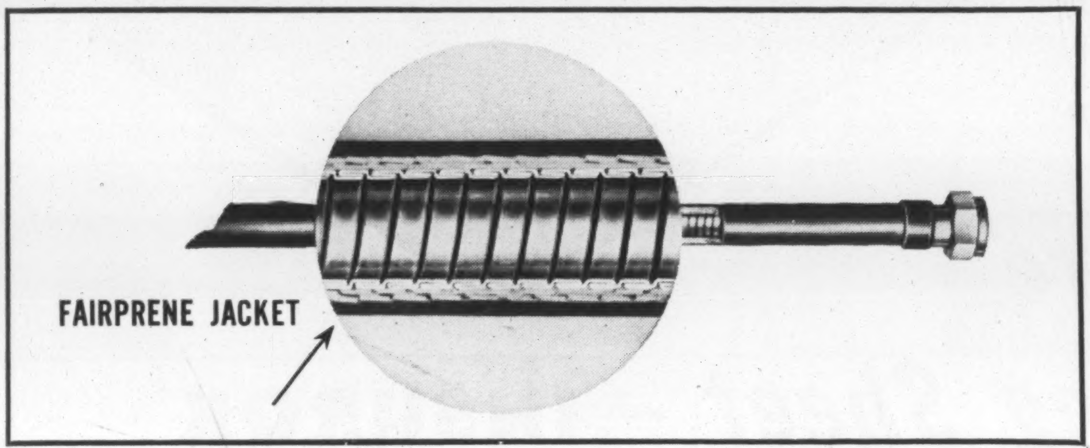
To meet severe high- and low-temperature operating requirements, tests are being conducted on Du Pont "Fairprene" synthetic elastic compositions made with silicone rubber on glass fabrics. These silicone-rubber compounds show excellent adhesion to the glass fabrics, and form an extremely dense, tough, rubbery film. The end uses in mind in these tests include, among others, airplane rocker-arm gaskets, engine baffles and air-duct coverings. The compositions being tested will have to stand up to such demanding service conditions as temperatures of 350°F. and continual flexing.

Du Pont's method is to work together with manufacturers in preparing specifications for silicone-rubber products, and then develop "Fairprene" compositions that will meet the manufacturers' needs. This work-together method assures customers of getting the specific grade of "Fairprene" that will do the job. It's a service *you* can call on, too.

Silicone rubber is just one of the elastomers used for "Fairprene." Other "Fairprene" compositions are made by impregnating, spreading or calendering elastomers on one or both sides of a woven fabric. The elastomer can be Neoprene, Buna-N, Buna-S, Butyl, or Thiokol—or a combination of these. The fabric can be cotton, "Orlon", nylon, rayon, glass, felt, asbestos, or some other fabric.

The general properties of "Fairprene" compositions—which can be "tailored" to fit your needs—include resistance to petroleum oils, greases, alcohol . . . to natural aging in air and oxygen . . . to extremes of heat and cold . . . to flex fatigue . . . to deteriorating action of fresh and salt water.

"Fairprene" is Du Pont's registered trade-mark for its line of products made from synthetic elastomers available in form of coated fabrics, sheet stocks without fabric insert and adhesives.



Close-fitting jacket of FAIRPRENE protects aircraft conduits

A moisture-proof jacket of tough Du Pont "Fairprene" protects Aircraft Shielding Conduits made by the American Metal Hose Branch of American Brass Company. As shown in the photograph, the molded "Fairprene" jacket covers the double wire braids over the four-wall flexible metal core of the conduit.

These conduits serve as aircraft engine spark-plug leads, where they have to stand up to such rigorous conditions as pounding vibration, extremes in temperatures and exposure to moisture. The "Fairprene" composition used was chosen for its ability to meet just such demands. It resists abrasion, withstands vibration, won't deteriorate in contact with oil or gasoline, keeps its toughness and flexibility at low and high temperatures.

Since this "Fairprene" composition is molded directly onto the conduit, it forms a tight, uniform, lightweight covering that needs no metal clamps.

This is another example of how versatile Du Pont "Fairprene" is already serving industry in many ways, with new applications being developed daily. Among the uses in which "Fairprene" compositions have proved successful are sensitive diaphragms, all types of gaskets, weather-stripping adhesives, apron and protective cloth materials, watertight seam sealants, grease seals, oil-line coverings—and others too numerous and varied to fit here.

TECHNICAL HELP FOR YOU

Du Pont engineers are eager to help you evaluate "Fairprene" for designing new products, or for improving your present products or manufacturing processes. They'll gladly work with you in engineering special grades of "Fairprene" to fit your specific needs. For prompt assistance, fill out and mail the coupon today.

"Engineered to do the job better"

SEND COUPON TODAY FOR INFORMATIVE BOOKLET ON "FAIRPRENE"

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Fairfield, Conn.

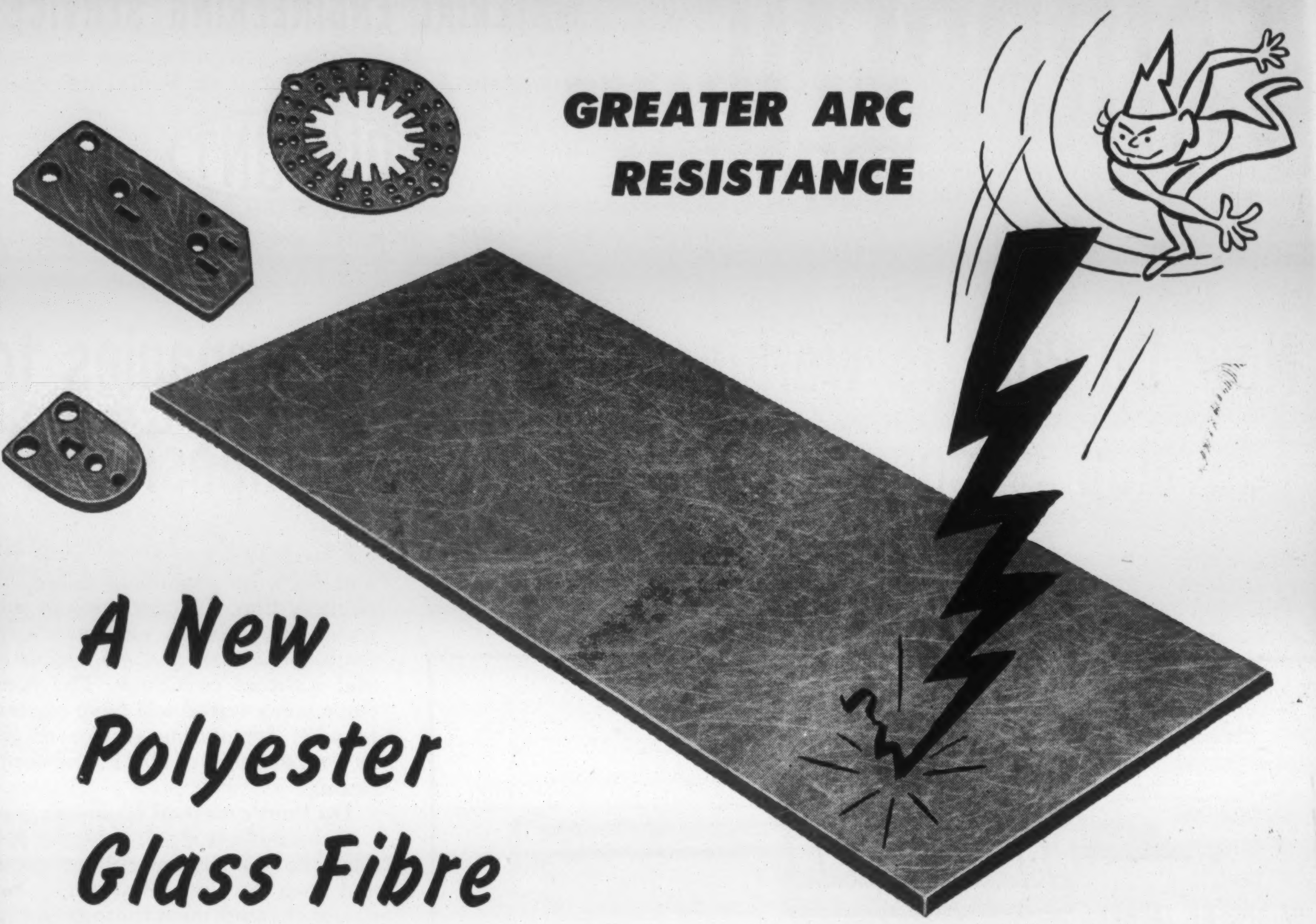
☐ Please send me your free booklet on "FAIRPRENE"

☐ I am also interested in new "Fairprene" silicone-rubber compositions

☐ I am interested in learning more about Du Pont technical assistance. (No obligation, of course.)

*Name*____________________ *Title*__________
*Firm*____________________________
*Address*__________________________
*City*________________ *State*__________

• For more information, turn to Reader Service Card, Circle No. 351



GREATER ARC RESISTANCE

A New Polyester Glass Fibre Insulating Sheet – INSUROK® XT-200

- GOOD ELECTRICAL PROPERTIES
- EXCELLENT STRUCTURAL STRENGTH
- HIGH HEAT RESISTANCE
- LOW MOISTURE ABSORPTION
- PUNCHES COLD TO INTRICATE SHAPES

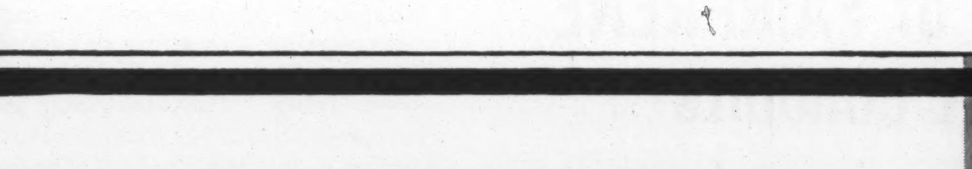
● If you are looking for an insulating laminate that combines excellent electrical properties with good structural strength, consider this new Richardson laminate. INSUROK XT-200 is an excellent material for pole insulators, cable holders and switches, where arc resistance is important, as well as for motor-generators, transformers, switchgear, electroplating equipment, and various kinds of electrical and electronic heating devices. Moreover, INSUROK XT-200 has very satisfactory fabricating qualities. It is available in sheets 34″ x 34″, in thicknesses of 1/16″, 1/8″, and 1/4″. The Richardson Company will be glad to supply further information and samples.

Send for Data Sheet XT-200

The RICHARDSON COMPANY

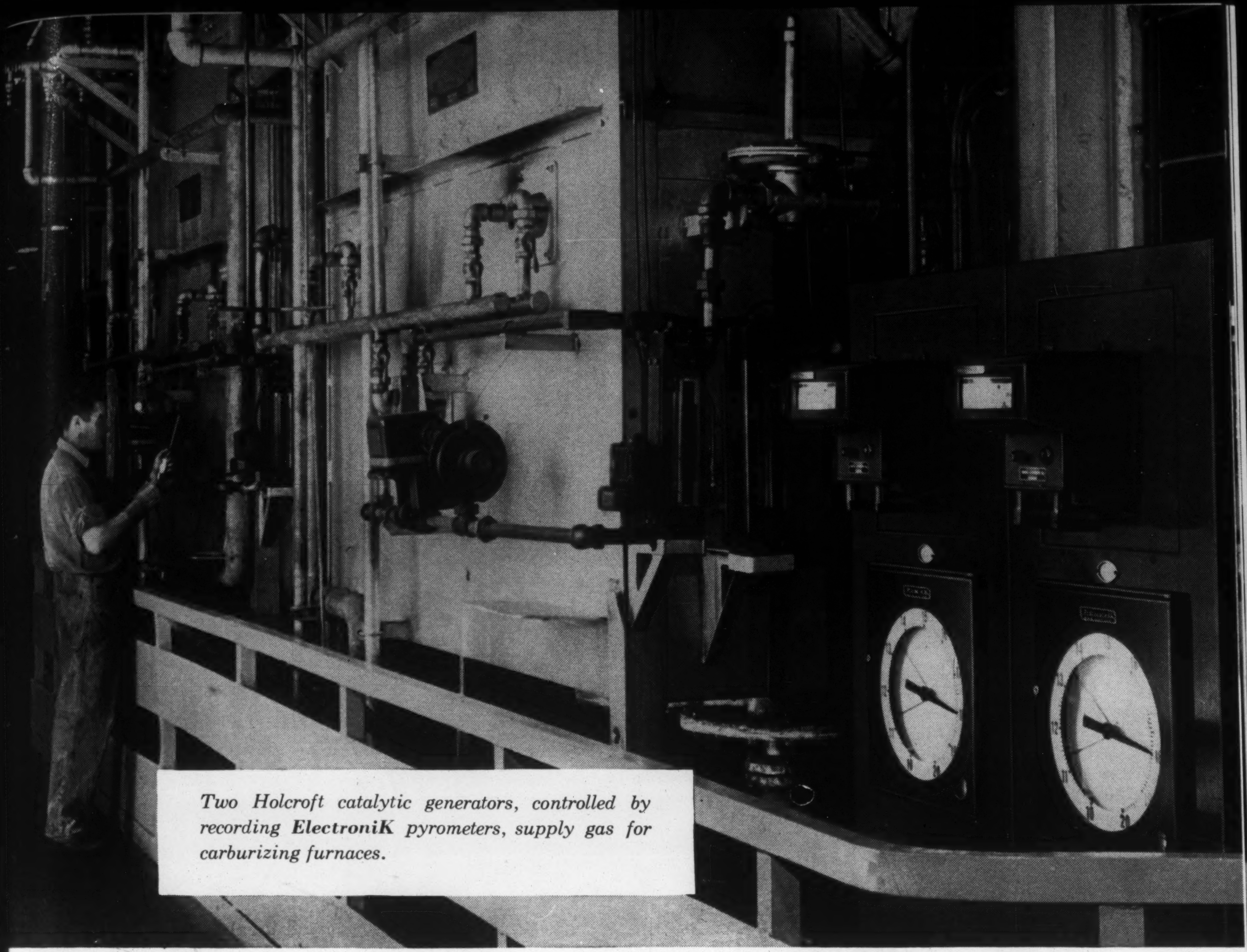
FOUNDED 1858

2782 Lake Street, Melrose Park, Illinois (Chicago District)



MELROSE PARK, ILL. | INDIANAPOLIS, IND. | NEW BRUNSWICK, N. J. | NEWNAN, GA. | OGDEN, UTAH | TYLER, TEXAS

For more information, turn to Reader Service Card, Circle N



Two Holcroft catalytic generators, controlled by recording ***ElectroniK*** *pyrometers, supply gas for carburizing furnaces.*

Ford transmission shafts

THE MECHANIZED heat-treating facilities at Ford Motor Co.'s Mound Road plant carburize about 480 transmission shafts per hour. Supplying carburizing gas of exactly the right composition is essential to the quality of this high production operation. And, like many other heat-treating problems, gas generation profits by the accuracy of *ElectroniK* control.

Carburizing gas is produced by two Holcroft units, each having a capacity of 3600 cubic feet per hour. Used one at a time, with the other as standby, these units feed gas to a pair of pusher-type Holcroft furnaces.

Natural gas and air are cracked catalytically in the generating unit to produce the carrier gas. Responsibility for keeping cracking temperatures within exacting limits is assigned to *ElectroniK* Controllers, which regulate fuel input to the six burners heating the combustion retort. Regardless of changes in fuel pressure and gas demand, these instruments maintain cracking temperatures with the precision required for accurate control of gas analysis.

Whatever your own heat-treating problem, you'll get the best in control performance with *ElectroniK* instrumentation. The choice of leading furnace manufacturers, these controllers have proved their performance and dependability in thousands of heat-treating departments. It will pay you to specify *ElectroniK* instrumentation on any furnaces you're planning for new plant or for modernization programs.

Your nearby Honeywell sales engineer will be glad to discuss your specific requirements . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

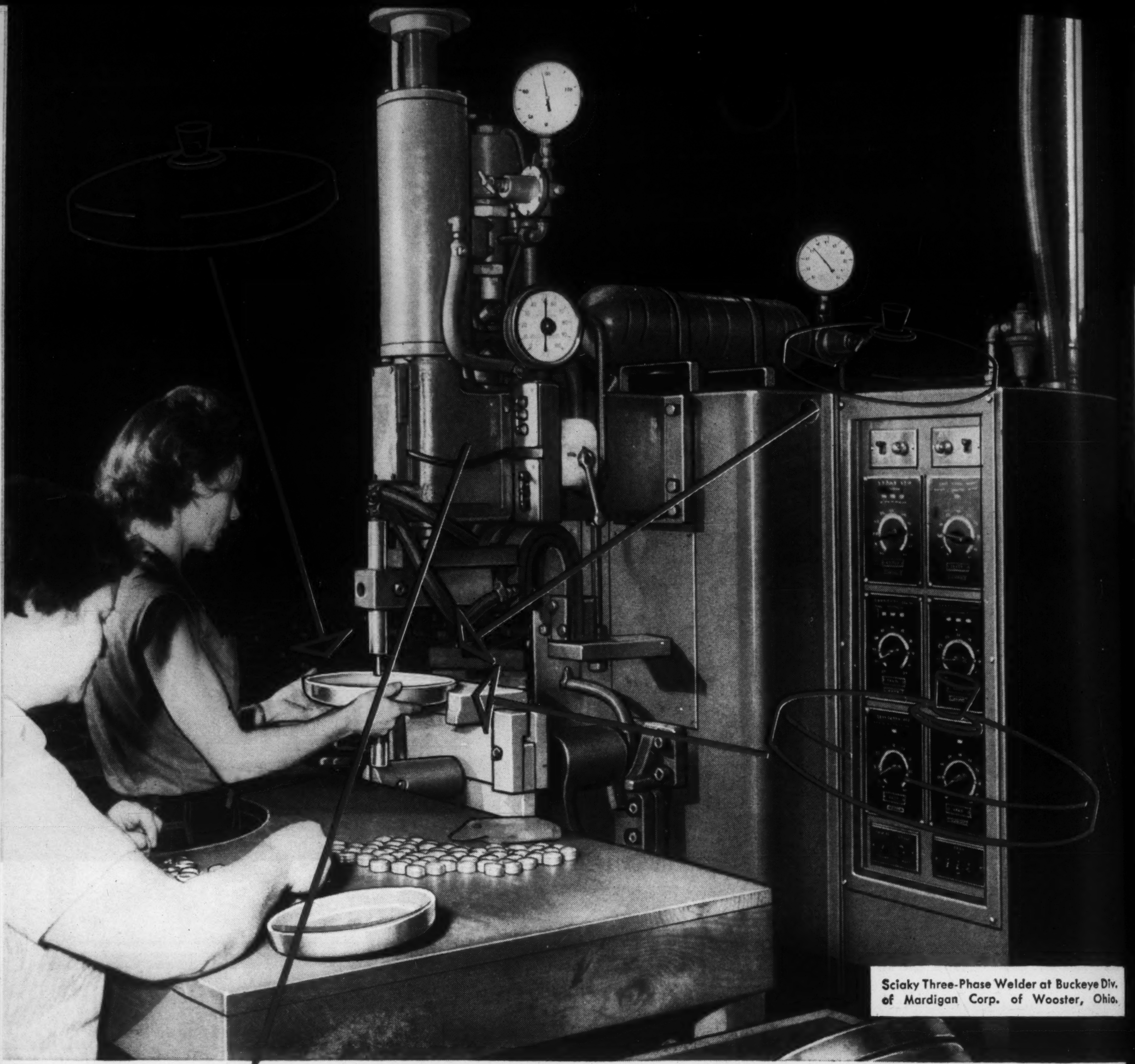
- **REFERENCE DATA: Write for Catalog 54-1, "Furnace and Oven Controls."**

H
HONEYWELL

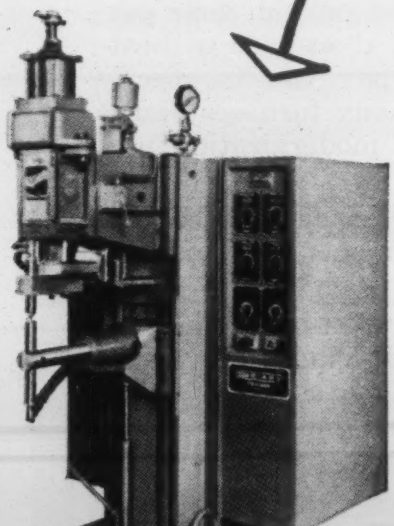
MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

For more information, turn to Reader Service Card, Circle No. 456



Sciaky Three-Phase Welder at Buckeye Div. of Mardigan Corp. of Wooster, Ohio.



Sciaky Three-Phase Improves Design, Appearance, and Jumps Production 375%

The use of Sciaky patented Three-Phase balanced load, high power factor, resistance welding enabled Buckeye to improve the design and jump production 375% on pot and pan covers. Sciaky Three-Phase readily solved a limited power problem. Fabricating costs were reduced sharply, and the basic design of the product was greatly improved. In welding, a disc and a drawn .025 aluminum cup are placed over the lower spot welding electrode. The .104 aluminum cover is inverted over the cup and one stroke of the welder completes the assembly. Then the hollow knob is screwed into place completely covering cup and flush with the cover. The airspace within the knob protects miladies' fingers from burns. Write for complete details of the welding operation at Buckeye in "Resistance Welding at Work," Vol. 4 - No. 2.

Buckeye's improved design for cover knobs is another fine example of Sciaky basic thinking — welders designed to do *more useful work* at *lowest operating cost* with *maximum reliability.*

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY

Sciaky Bros., 4929 West 67th Street, Chicago 38, Illinois

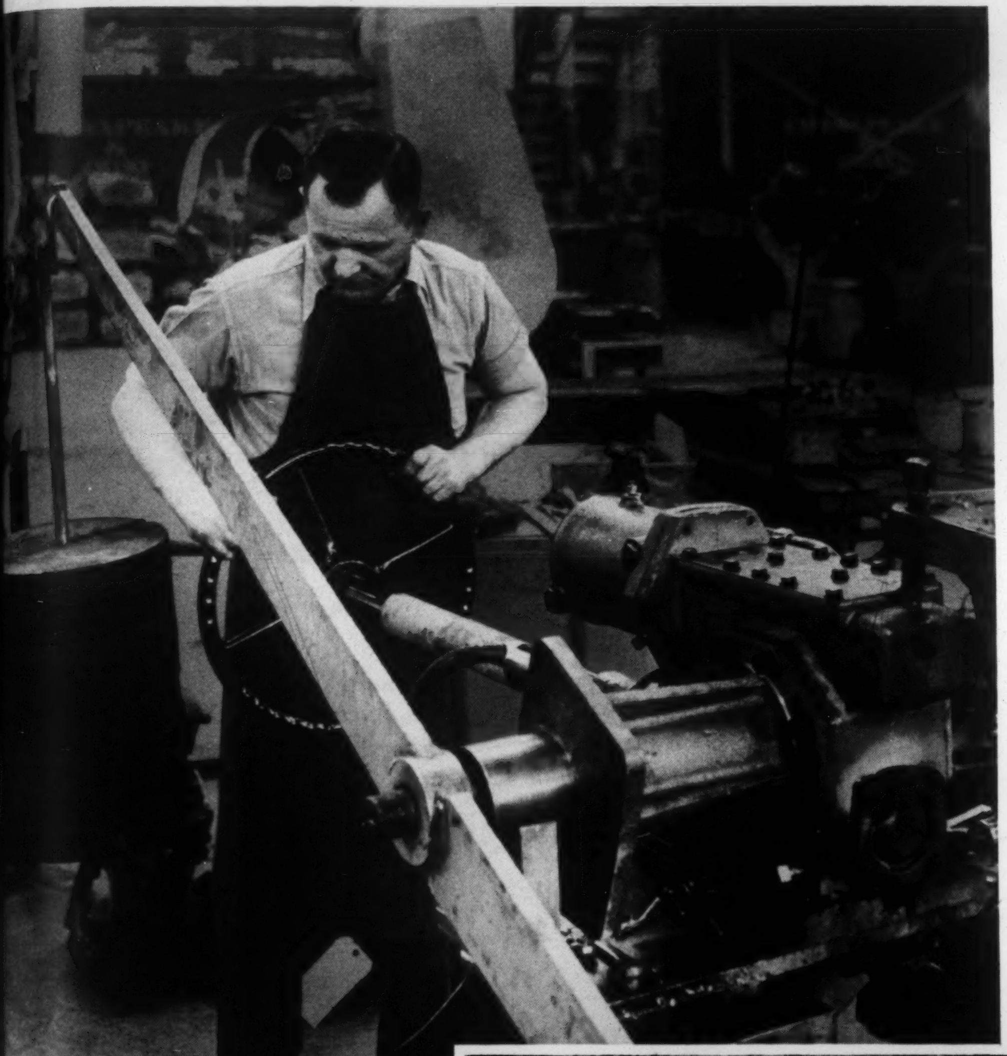
For more information, turn to Reader Service Card, Circle No. 439

For more information, Circle No. 478 ➤

New facts for your file on

USS CARILLOY STEELS

USS Carilloy steels minimize distortion in power steering units for cars

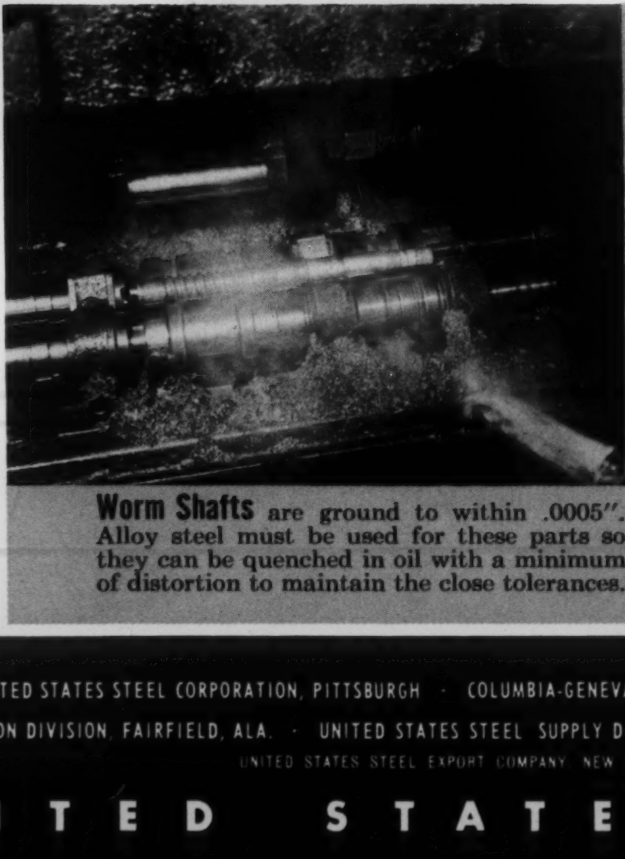


Torque Testing of completed steering unit. Even the heaviest steering loads require only 3 lbs. pull by the driver of an automobile with power steering. In addition, road shocks are cushioned by the power steering unit.

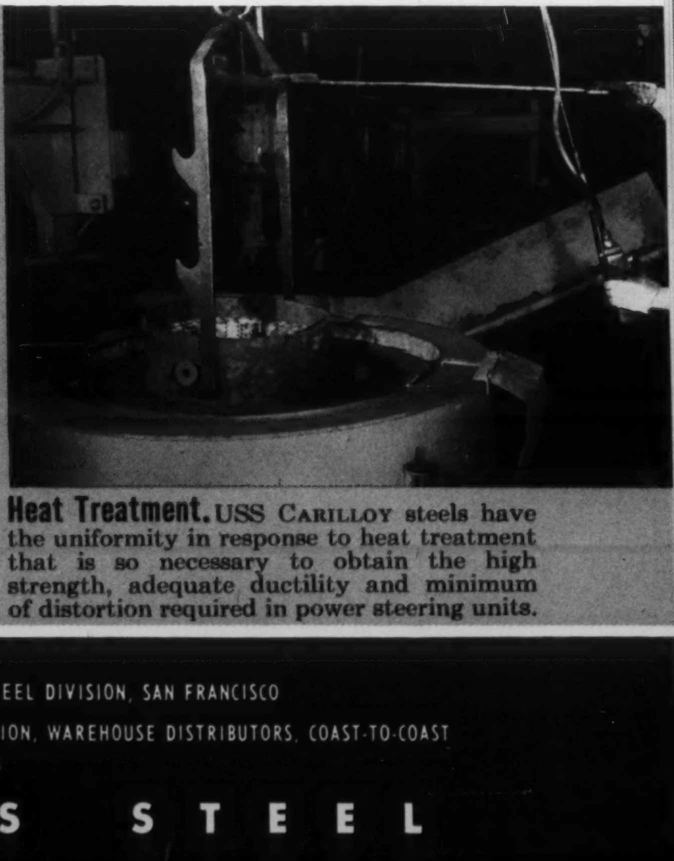
POWER steering units are precision machines. Every part must fit exactly. Parts must be interchangeable. They must be made to finished tolerances as small as .0001″. They must be heat treated with minimum distortion.

These rigid requirements dictate the use of accurately controlled *alloy* steels that can be *quenched in oil*. These steels must respond uniformly to heat treatment, time after time, so that many thousands of parts can be made —*all exactly alike*. USS CARILLOY steels are used extensively in power steering units because they help to insure the uniformity that is essential in all critical parts.

CARILLOY steels are giving excellent service daily in a wide variety of precision parts for automobiles, aircraft, trucks, farm equipment, construction machinery, rotating machines, and many other applications. These high quality steels are meeting some of the toughest requirements known to industry. They can meet yours. For information write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.



Worm Shafts are ground to within .0005″. Alloy steel must be used for these parts so they can be quenched in oil with a minimum of distortion to maintain the close tolerances.



Heat Treatment. USS CARILLOY steels have the uniformity in response to heat treatment that is so necessary to obtain the high strength, adequate ductility and minimum of distortion required in power steering units.

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

USS HIGH STRENGTH STEELS

Roof purlins of USS COR-TEN steel are 28% lighter, cost 17.5% less than carbon steel

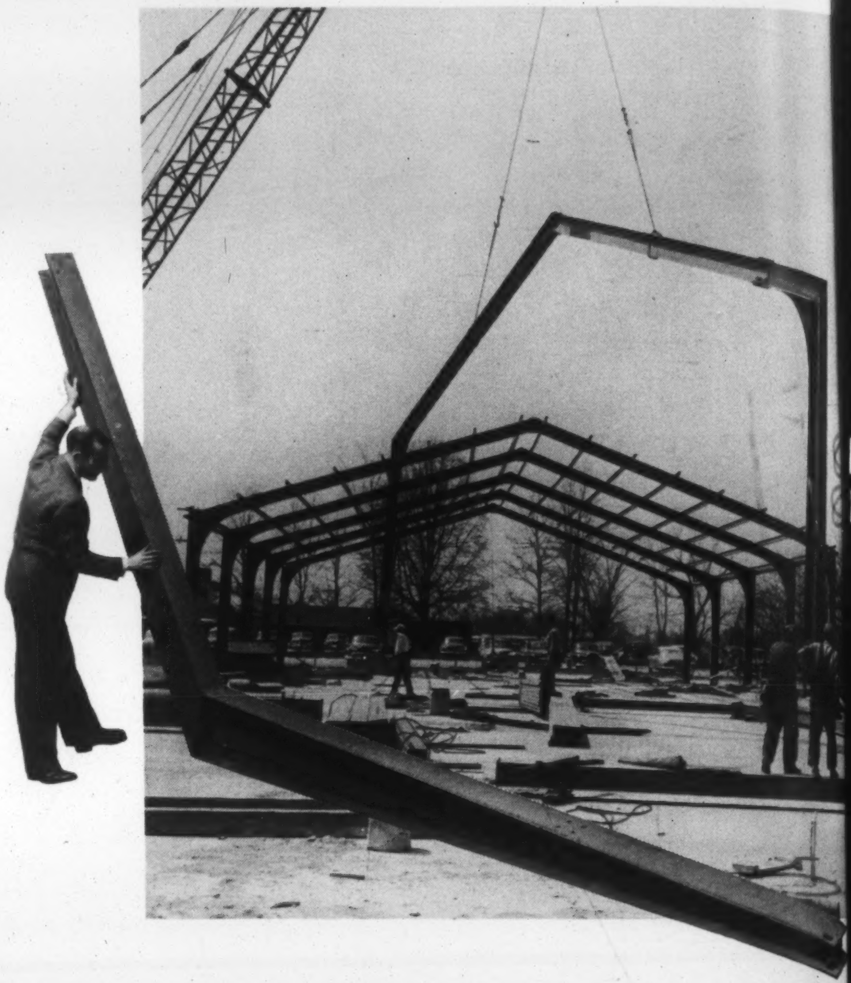
● By taking advantage of the higher strength of USS Cor-Ten steel, The Steelcraft Manufacturing Company, Rossmoyne, O., manufacturers of Standard Steel Buildings, was able to substantially reduce both the weight and the cost of the purlins used in the rigid-frame steel buildings they have made for the U.S. Government and for commercial and industrial use.

Although the 20-ft. purlin sections made of 14 gage USS Cor-Ten steel have the same load carrying capacity as 12 gage carbon steel, they are 30.4 lbs. lighter and cost $2.63 less each.

The manufacturer estimates that the rigid-frame construction itself reduces cost about 20% when compared to conventional construction, and when Cor-Ten steel is used, costs are still further reduced about 25%.

USS Cor-Ten steel also ensures other important economies. Its lighter weight not only makes handling and assembly easier but materially reduces freight costs, both when the steel is shipped from the mill and again when the building sections are transported to the erection site.

Because Cor-Ten steel has 4 to 6 times the resistance to atmospheric corrosion as carbon steel, and because paint adheres more tightly to it, the Cor-Ten steel purlins will outlast ordinary steel construction and require minimum maintenance through the years.



USS MAN-TEN steel reduces weight, assures greater strength and durability in Cardwell "Trailerig"

● Extreme portability which keeps moving costs to a minimum is obtained in this well-known portable oil drilling rig which combines the draw works assembly, including the mast, with the trailer frame.

This compact, completely unified machine has capacity for 5,000 foot slim hole drilling and 10,000 foot workover. It carries a 90- or 96-foot mast which can be telescoped and folded down so that the "Trailerig" in roading position is only 8 feet wide, 13½ feet high and 59 feet long.

To keep weight as low as possible without sacrificing ruggedness, the Cardwell Mfg. Co. of Wichita, Kansas, has built the bridge-type trailer frame and working platform of high strength USS Man-ten steel and reduced weight 6,000 lbs. as compared to carbon steel construction.

Additional weight has been saved in the mast in which all structural members are of 8″ x 11.5 lb. Man-Ten steel channels. These are considerably lighter than if carbon steel of equal strength had been used.

But USS Man-Ten steel does more than save weight in this construction. Its higher fatigue strength—40% greater than carbon steel—and its greater strength and abrasion resistance pay off in increased durability which minimizes maintenance and helps to keep the "Trailerig" steadily on the job when making hole.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

U S S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

Stainless Steel milk dispensers fabricated at rate of 120 units per day

BY UNITED REFRIGERATOR

The experience of United Refrigerator Company, Hudson, Wis., shows how adaptable Stainless Steel is to mass production operations. Milk dispensers—used for serving cold milk in glasses in schools, restaurants and the armed services—are being fabricated from Stainless Steel at a rate of more than 120 units per day.

United uses no special equipment in fabricating Stainless Steel. Such operations as shearing, punching, notching, braking, soldering, spot welding and grinding take place on equipment used for fabricating mild steel.

Shop practices are much the same, too. Blades are kept a little sharper, dies a little smoother and greater care is exercised to prevent marring the smooth surface of Stainless.

The result is a product with a high degree of sales appeal . . . made from a material perfectly suited for the sanitary nature of the application.

Stainless Steel milk dispensers after assembly at United Refrigerator Company.

Stainless Steel is not difficult to fabricate

-it's just different

You pay no penalty in shop procedure to obtain the outstanding sales benefits of Stainless Steel. You can usually use the same equipment used for carbon steel with the addition of a little more power and a little more care.

So put Stainless Steel into your designs and into your selling. Our representatives will be glad to help you select the proper grade and fit it to your fabricating procedure.

Polishing the inside of a 30-quart bowl at ACF Industries.

Mixing bowls -12 to 160 quarts- drawn from Stainless Steel

ACF Industries, at its Milton, Pa. works, fabricates a line of industrial mixing bowls used by bakeries, restaurants, chemical plants, cosmetic manufacturers and the like. Depending on service conditions, the bowls are of carbon steel or Stainless Steel. But the same fabricating equipment is used for both.

Fabrication of a 30-quart Stainless bowl begins with two draws on a 1000-ton hydraulic press. The 31½″ circle is first reduced to 20″ and then to 14½″ making a bowl 15″ high. Stainless used is 16 gage.

The bowl is then annealed and pickled, the flange is trimmed, it is spun and beaded on a lathe, the outside is polished, handles and fittings are welded on and the inside is polished.

Even dies are used interchangeably between carbon and Stainless. Stainless requires only a little more careful handling.

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

In a hot-blast main . . .

Resistance to rugged operating conditions is provided by Refractory Concrete at this Y-connection in hot-blast main at the National Tube Division of United States Steel Corporation, McKeesport, Pa. Refractory Concrete provides smooth, jointless construction.

. . . A tough problem solved by refractory concrete

A hot-blast furnace main presents a tough refractory structural problem where the curved arches meet in a Y-intersection. How refractory concrete solves the problem is shown above. Repairs and maintenance were reduced, and time was saved both in installation and operation.

Such jobs call for a refractory that resists extreme conditions of abrasion and thermal shock. In an emergency, refractory concrete, made with Lumnite* calcium-aluminate cement, was tried. Result: a successful job, and refractory concrete is now commonly used for this purpose.

Refractory concrete may solve some of your refractory problems. It withstands temperature of 2600°F. or more, has low volume change, and is highly resistant to thermal shock.

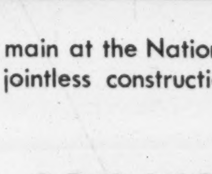
FOR CONVENIENCE, you may prefer to make refractory concrete with prepared castables (packaged mixes of Lumnite Cement and aggregates selected for specific temperatures and insulation service—add only water). They are made by refractory manufacturers and sold through their dealers. For more information, write Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

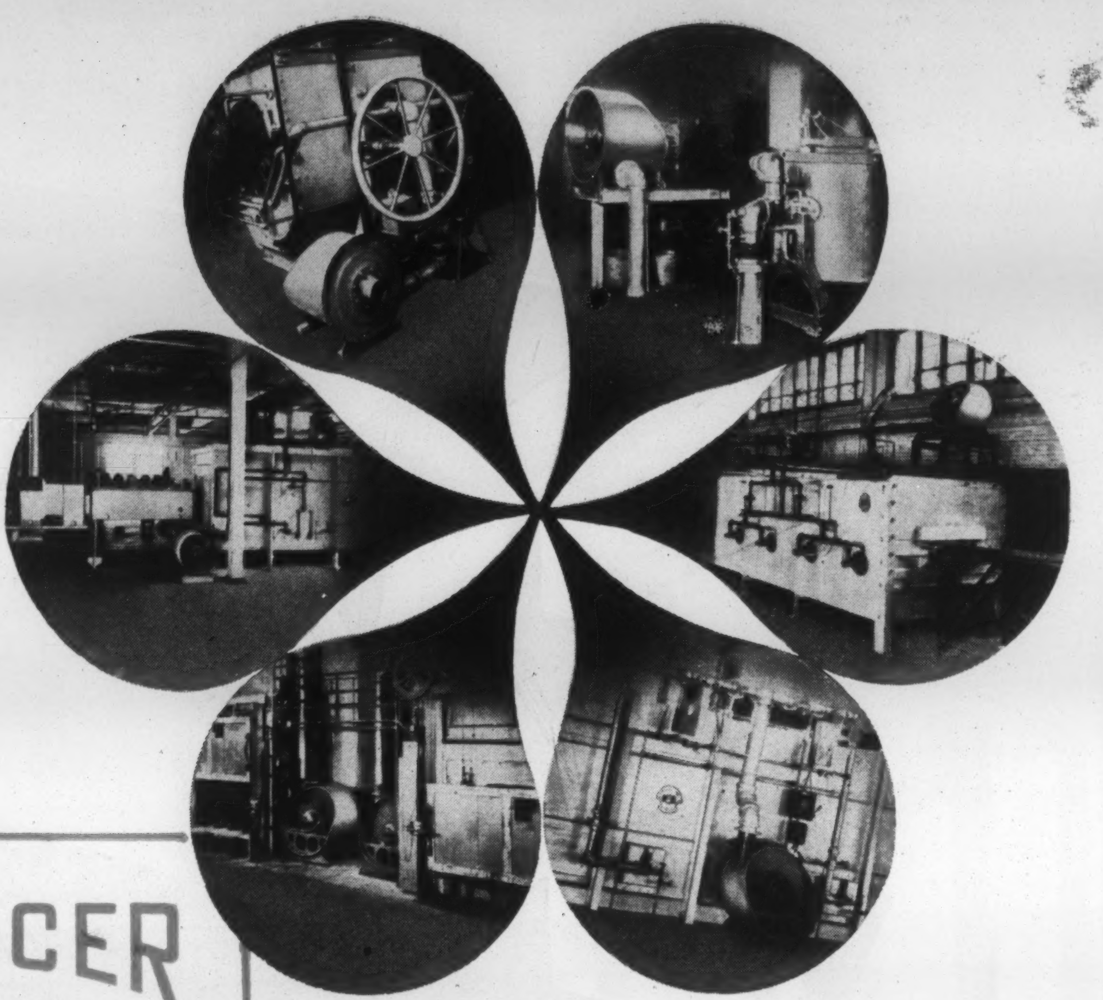
MP-L-89

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT



UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.



SPENCER
HARTFORD
TURBOS

The illustration shows Rockwell furnaces for carburizing, crucible melting, bright annealing, casting annealing, aluminum annealing and coil wire annealing—all equipped with Spencer Turbo-Compressors.

are recommended by

THE W. S. ROCKWELL CO.

Since 1918, now more than a quarter of a Century, Rockwell has recommended Spencer Turbos in connection with their furnaces and ovens. A few recent installations are shown above.

Spencer Turbos have met the test of time—in years and in continuous service with a minimum of shut downs and maintenance costs. The simplicity of design with wide clearances, low peripheral speeds and only two bearings to lubricate is partly responsible. Other features are described in Bulletin No. 126-A illustrated below.

SPENCER
TURBO-COMPRESSORS

THE SPENCER TURBINE COMPANY

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494-A

Manufacturers of Turbo-Compressors and Heavy Duty Vacuum Cleaners

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REVERE
MEATS
COPPER ★ BRASS
1801
REVERE
ALUMINUM

Today . . . competition-minded manufacturers on all sides are finding logical new reasons to use more and more aluminum sheet products. Aluminum's ready workability, corrosion resistance, strength, ease of welding and joining, and the way it lends itself to surface finishes of distinction—all very often combine to make it first choice in metals.

Revere can supply you, not only with a full line of aluminum sheet products, but with aluminum tube, extruded products, electrical bar, forgings and rolled shapes of the finest quality. Added to these are Revere's renowned copper and brass products which have been staples of American industry for more than 100 years.

REVERE KNOWS ITS A-B-C's

ALUMINUM BRASS COPPER

Why not add the Revere A-B-C's to your own alphabet of manufacturing knowledge and experience? Call Revere NOW. Revere Copper and Brass Incorporated, *Founded by Paul Revere in 1801*, Executive Offices: 230 Park Avenue, New York 17, N. Y.

For more information, Circle No. 443

ALUMINUM

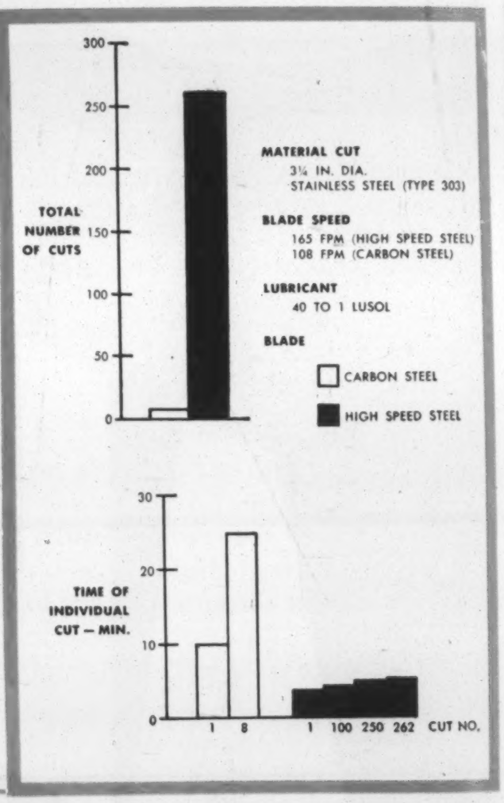
*Why **Moly** alloy steels are in your future*

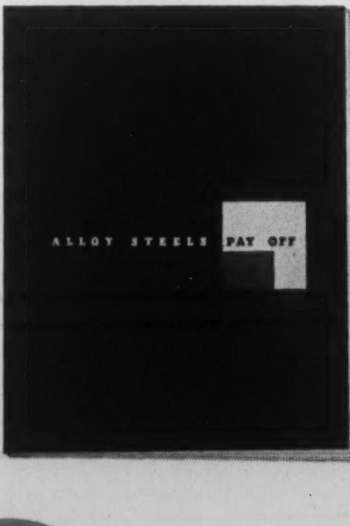
CUTTING LIFE INCREASED 10 TIMES

with

Moly tool steels

the part	**BAND SAWS**
the problem	Carbon-steel band-saw blades are usually made of a tool steel with about 1.25% C. For normal usage band saws make smoother and straighter cuts than hack saws. However, normal band saws run into difficulties when they're used as cut-off saws for materials with different machining properties.
the pay-off	The Henry G. Thompson & Son Company developed a moly high-speed steel, cut-off band-saw blade for stainless steel and other materials on a production basis. The chart shows graphically the results: cutting life of saw increased, time per cut shortened.





If you make, use, specify or buy steels you need a copy of "ALLOY STEELS PAY OFF"

Such topics as:

air valve stems on coal washers, anchor chain, annealing retorts, ball cages in universal joints, band saws, bolts, boring bars, bridges, bumpers for passenger cars, cable-tool and churn-drill bits, caustic evaporators, centralization feed pumps.

This big, fully documented 207 page book gives more than 50 complete case histories of alloy steel usage . . . such as outlined above. And each case history is an *idea*-starter of its own! Everything from "ANNEALING RETORTS" to "TRIMMER BLADES". Get your copy today. Address Dept. 6, on your letterhead, please. *Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.*

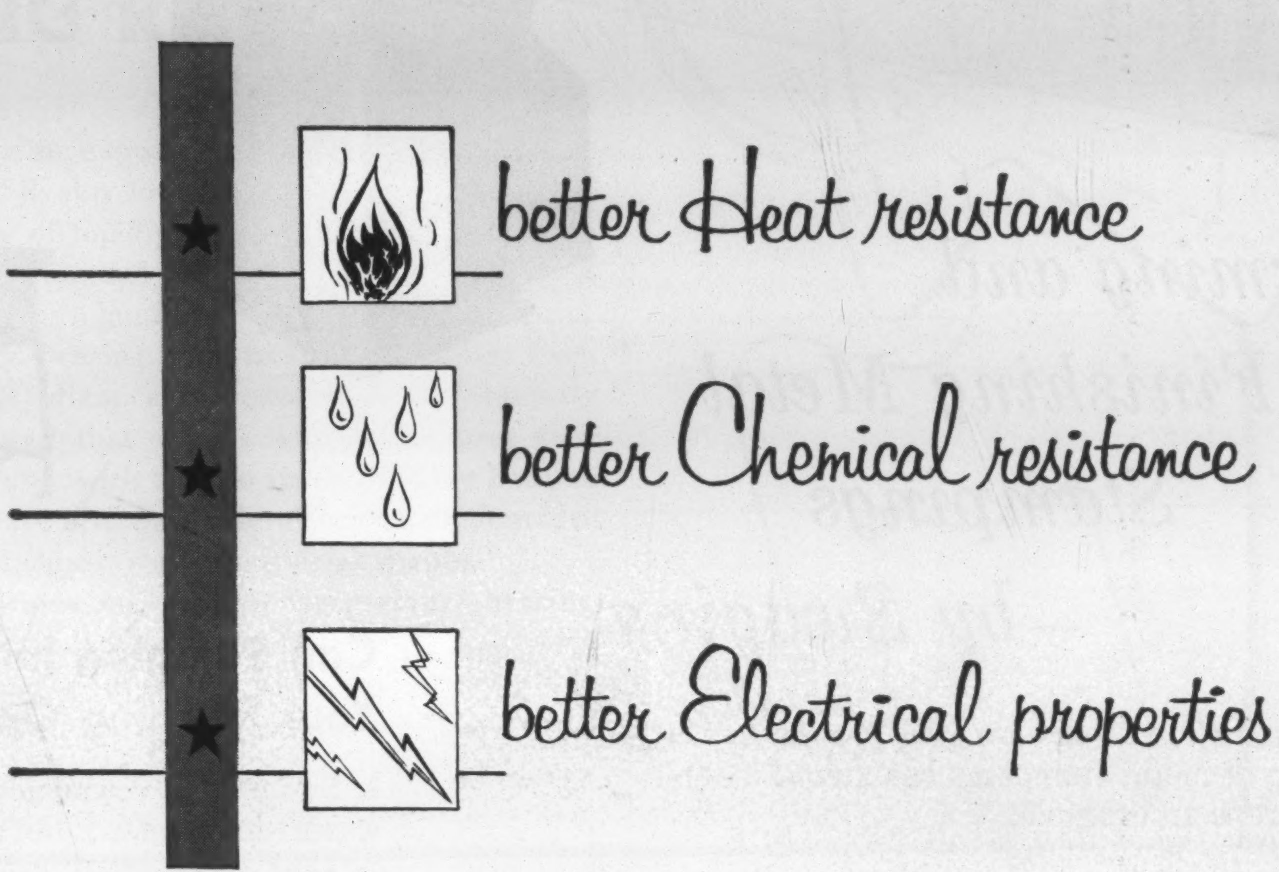
This advertisement is printed in one shade of molybdenum orange, a pigment widely used for its striking color and good coverage — ideal for paint on industrial equipment . . . brings high visibility that means extra safety.

CLIMAX MOLYBDENUM

For more information, turn to Reader Sevice Card. Circle No. 390

Important news!

EPON® resin 828 with new Curing Agent CL gives



If you are among the many users of Epon resin 828 for casting, laminating or other structural applications—you will welcome this new development of Shell Chemical's continuing research program.

Curing Agent CL* produces Epon resin polymers with improved mechanical and electrical properties at temperatures as high as 300° F. After three hours' immersion in boiling water or acetone, glass cloth laminates of Epon resin 828 and Curing Agent CL retained more than 95% of their initial dry flexural strength. And with Curing Agent CL you can use the "B-stage," or pre-curing, process—permitting dry layups and specialized casting techniques.

Your request will bring you a sample of Epon resin 828 and Curing Agent CL for evaluation, as well as a copy of Technical Bulletin SC:54-10. Write for them—today.

Curing Agent CL is Shell Chemical Corporation's name for metaphenylene diamine. We do not manufacture Curing Agent CL. It is available in commercial quantities from E. I. du Pont de Nemours & Company and National Aniline Division, Allied Chemical & Dye Corp.

*A development of Shell Chemical laboratories. Patent applied for.

SHELL CHEMICAL CORPORATION

CHEMICAL PARTNER OF INDUSTRY AND AGRICULTURE

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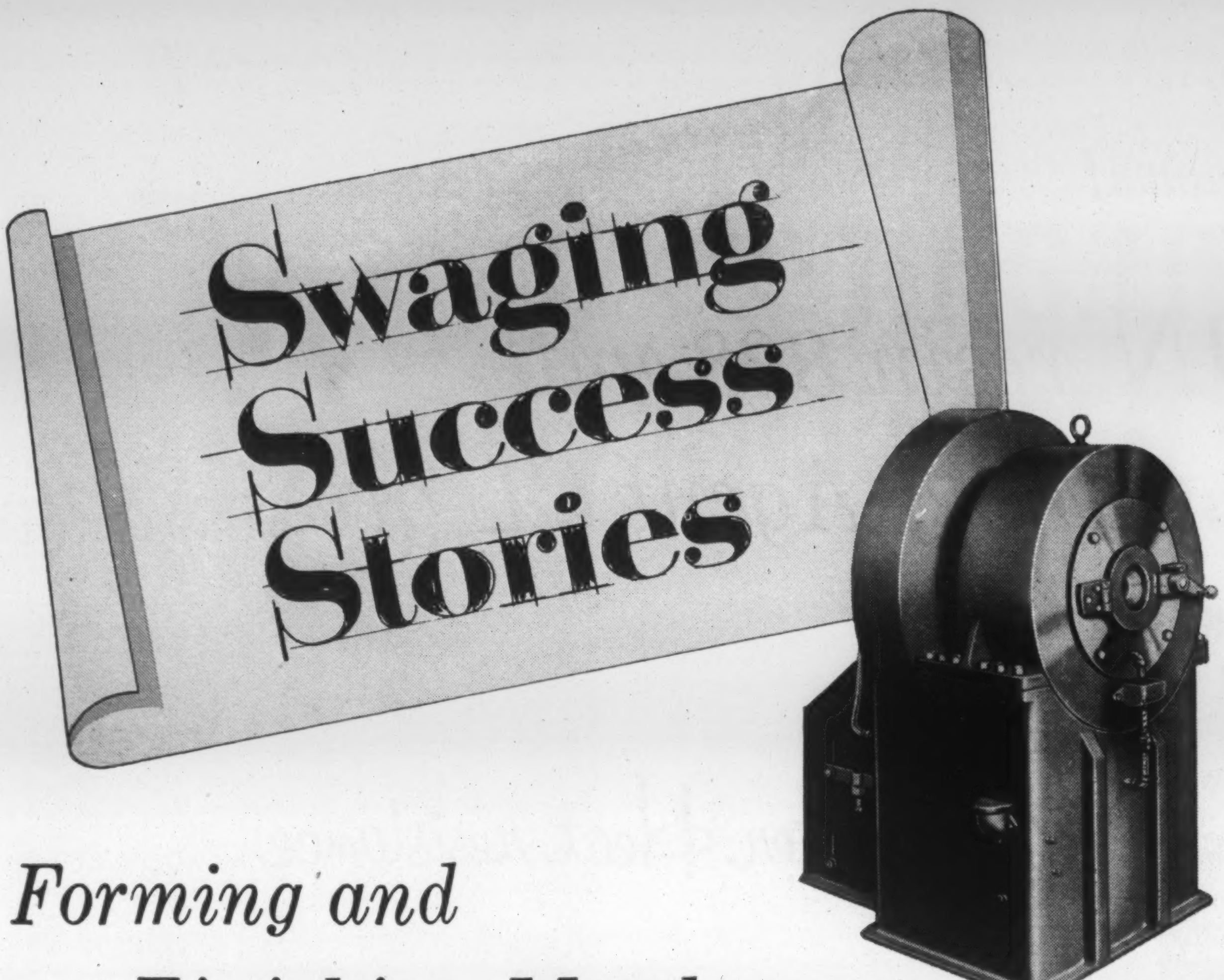
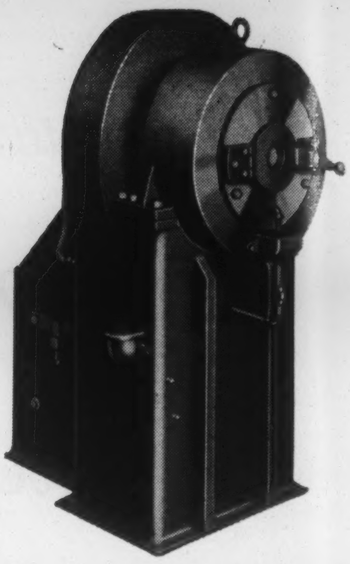
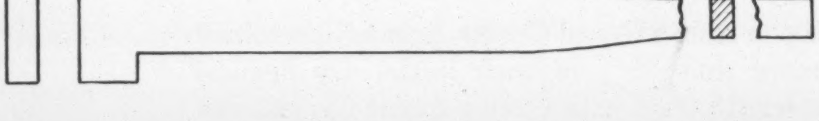


Swaging Success Stories

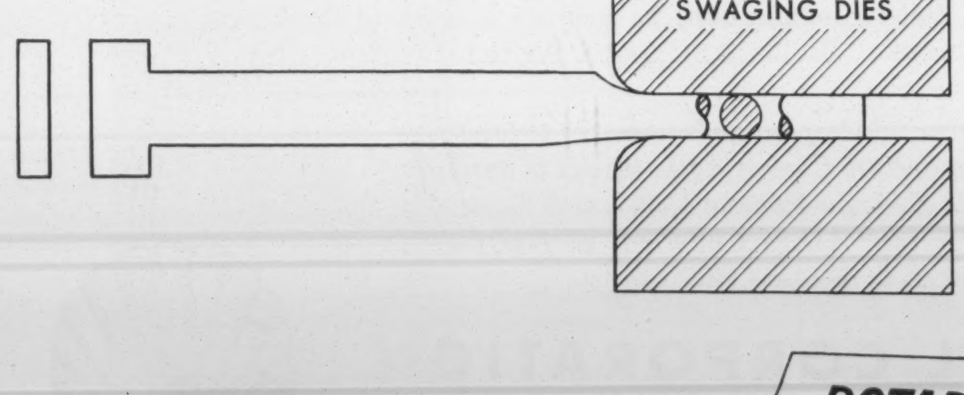


Forming and Finishing Metal Stampings —by Swaging

The application of the swaging process to the forming and finishing of metal stampings has almost unlimited possibilities. Here is an example.



Flat stampings like this one can be given rounded sections, accurately sized, without turning or grinding, by one simple swaging operation.



Can Swaging Improve Your Forming Operations?

1. Swaging is economical—no chips, no wasted material
2. Swaging is simple—can be done by unskilled labor
3. Swaging is fast—gives you increased output of special shapes

Our informative booklet on Swaging may give you other ideas for your own "swaging success story." Why not write for it today?

THE TORRINGTON SWAGING MACHINE

THE TORRINGTON COMPANY
Swager Department
660 North Street, Torrington, Conn.
Makers of Torrington Needle Bearings

TORRINGTON *ROTARY SWAGING* MACHINES

For more information, turn to Reader Service Card, Circle No. 317

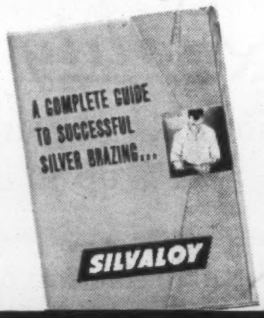
PREFORMED SILVALOY BRAZING RINGS

The APW outstanding experience in fabricating precision-made preformed Silvaloy low-temperature brazing rings—plus a full battery of top-flight equipment, has helped us to solve manufacturing and supply problems for many of the country's leading manufacturers.

Here, preformed brazing rings in sizes that range from .050″ diam. to 18″ diam. are produced in any quantity required, at a speed that assures delivery to meet your production schedules, with time to spare. Silvaloy Brazing Alloys, plymetal are also available of course, in standard forms, preformed shims, washers, special shapes.

When specifications call for low temperature brazing, call for dependable Silvaloy alloys. They're made with the precise properties you want —in forms best suited for most economical, high-speed production brazing.

FREE: SEND FOR THIS COMPLETE GUIDE TO SUCCESSFUL LOW TEMPERATURE BRAZING


A COMPLETE GUIDE TO SUCCESSFUL SILVER BRAZING...
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LOW TEMPERATURE SILVER BRAZING ALLOY

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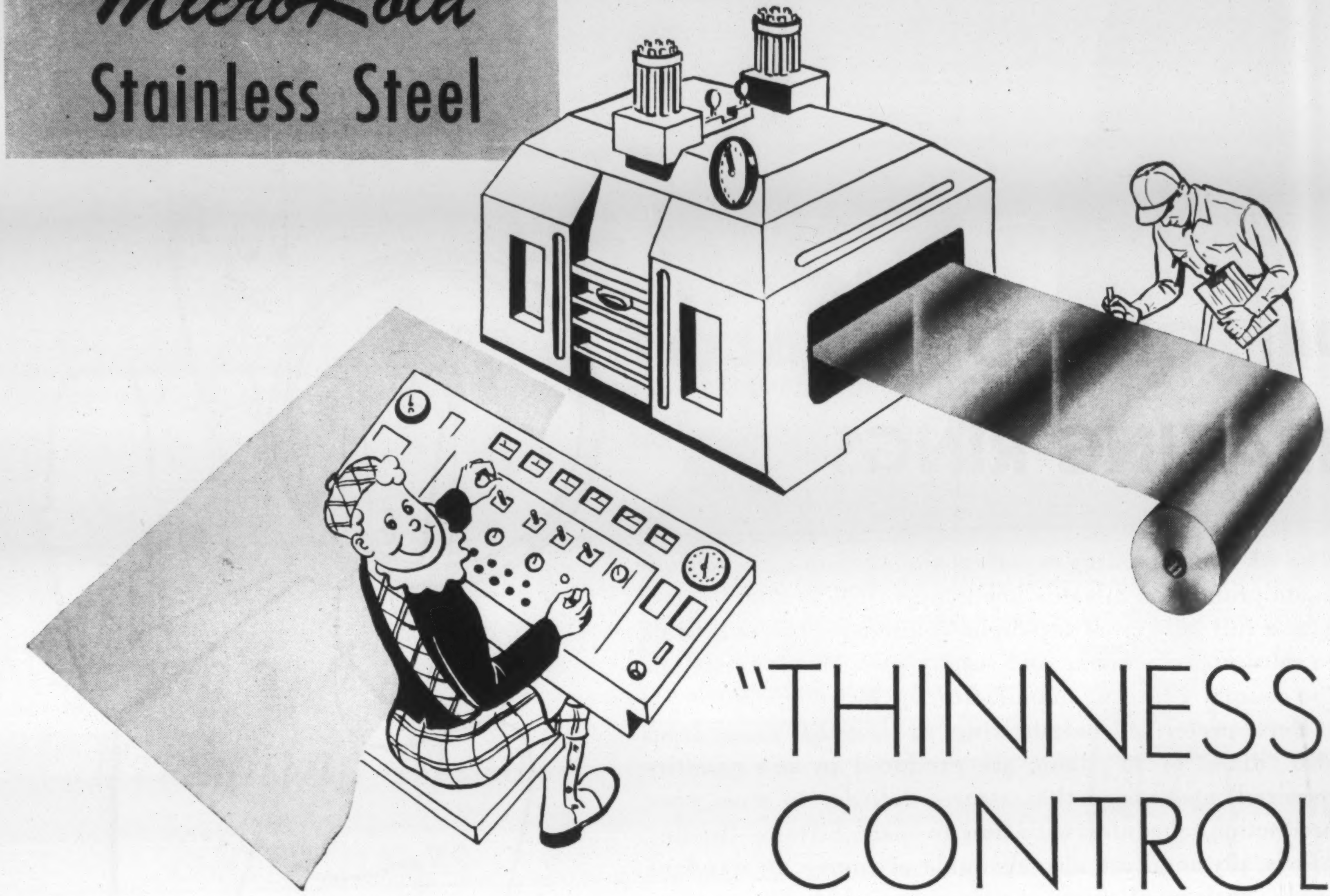
MicroRold®
Stainless Steel



"THINNESS CONTROL"

provides strip *Quality* in SHEET *Sizes*

Remarkable uniformity of gauge in MicroRold
Stainless Sheets up to 36″ wide.

The "Thinness Control" used in the manufacture of light gauge MicroRold Stainless Sheets assures you of the *same* dimensional accuracy as in strip stainless. Specified gauge thicknesses may be rolled in sheet sizes with tolerances as low as 3% average (plus or minus) as compared to the A.I.S.I. allowable of plus or minus 10%. This results not only in weight savings but also in fabricating economies.

With "Thinness Control" MicroRold's close adherence to a specified gauge will naturally result in a longer die life. Not only is MicroRold held closely to the specified thickness, but the "crown", or extra thickness in the center, is less in MicroRold than the "crown" in sheets rolled by conventional practice.

Regular use of MicroRold Sheet can give you more stainless area per ton or the equivalent area with lesser weight.

MicroRold Stainless Steel Sheets are available up to 36" wide and in gauges from .005 in commercial grades, finishes and temper.

Ask your steel warehouse distributor for
MicroRold with "Thinness Control"

Washington Steel *Corporation*
Washington, Pennsylvania

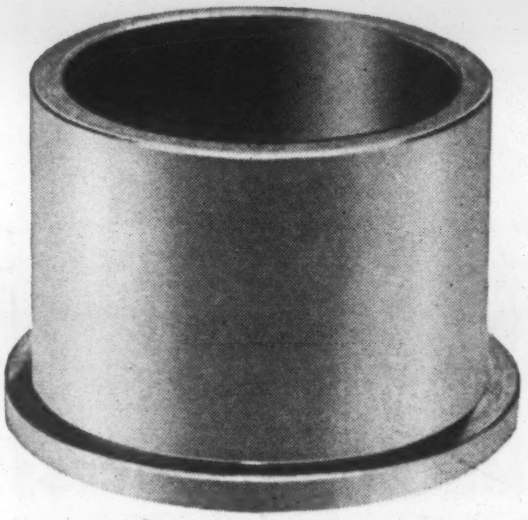
For more information, turn to Reader Service Card, Circle No. 399

BIG OR LITTLE . . . TOUGH OR EASY

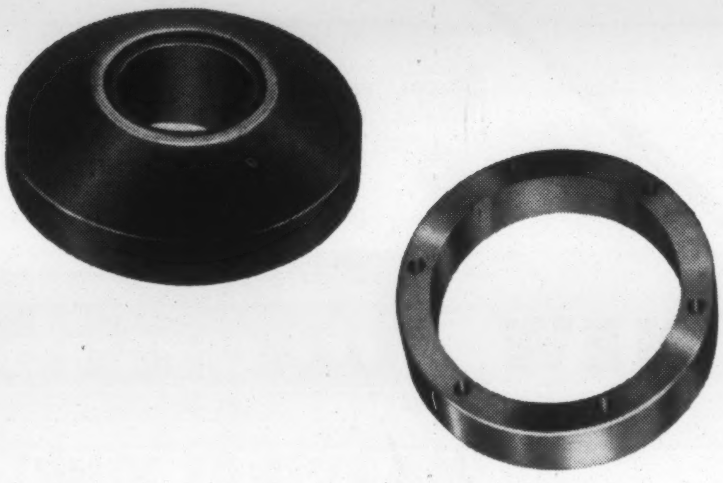
GRAMIX® SINTERED METAL PARTS

PRODUCED TO EXACTLY MEET ANY REQUIREMENTS

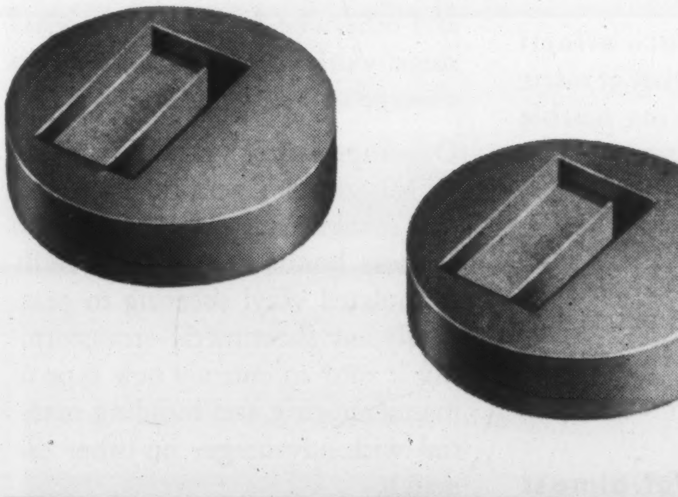
large and small pieces



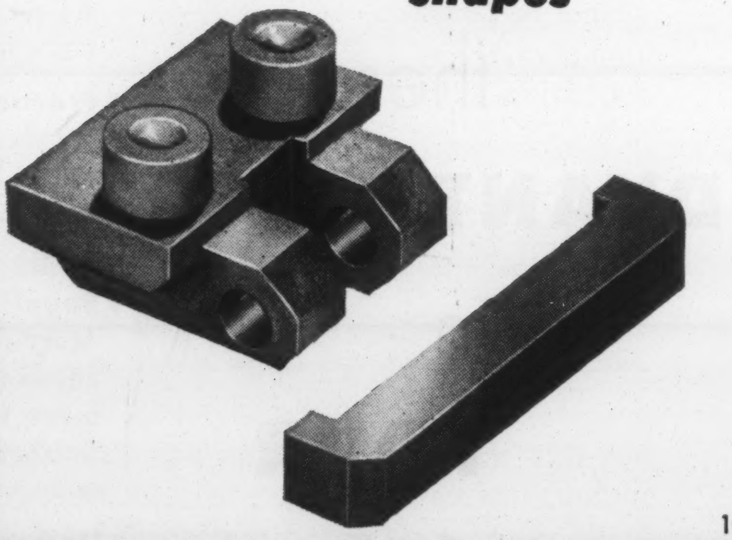
open or close tolerances



single and multiple compositions



simple or complex shapes



104

GRAMIX sintered metal bearings and parts can be produced to meet an extremely wide variety of applications and specifications. Even intricate shapes of close tolerances save considerable money as against similar parts machined from bar stock. With simple compositions and shapes not close in tolerance the costs are amazingly low. In addition our competent engineers will study the prints you submit and recommend the correct composition and design considerations to most practically and economically manufacture your parts. There is no obligation for this service, of course. Write for data book.

OUR 100th YEAR

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

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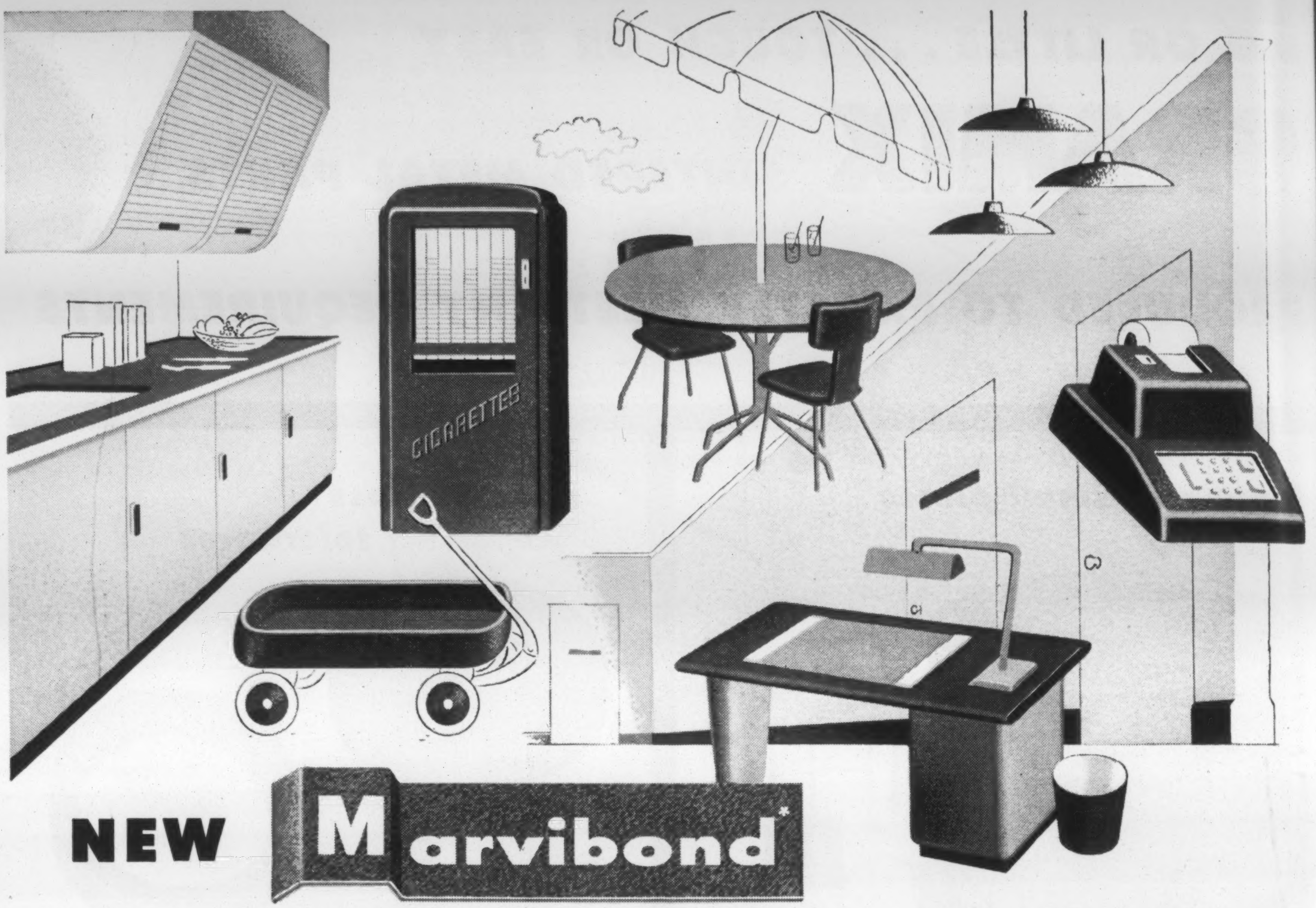

NEW Marvibond*

MARVINOL VINYL-TO-METAL LAMINATION PROCESS

puts these **ADVANTAGES** in **YOUR PRODUCT!**

- **Permanent protection against rust and corrosion!** Extremely chemical-resistant vinyl protects metal against many acids, alkalies, salt water, alcohol, household chemicals, corrosive industrial liquids and atmospheres.
- **Practically any surface effect!** Vinyl can be given a glossy or matte finish, leather-like grains, marble patterns, prints, or woven appearance.
- **Superior abrasion resistance!** Marvinol-metal laminate resists abrasion far better than paints, lacquers, varnishes, phenolic or alkyd finishes...will not chip, crack, or craze.
- **Uniform coverage of almost any thickness desired!**
- **Less costly fabrication!** The Marvibond process is carried out *before* your product is made—eliminates costly finishing operations. The laminate can be drawn, sheared, crimped, embossed, punched, and otherwise formed on standard metal-working equipment *without damage to coating or bond.*

Developed after years of research by Naugatuck Chemical engineers, this revolutionary new Marvibond process bonds colorful, specially formulated vinyl sheeting to practically any sheet metal—transforming it into an entirely new type of manufacturing and building material with advantages no other can match.

Machine Housings
Kitchen Cabinets
Wainscotting
Hospital Equipment
Lawn Furniture
Building Partitions
File Cabinets
Restaurant Counters
Desk and Table Tops
Toy Wagons
Industrial Drums
Lighting Fixtures
Vending Machines
Television Cabinets
Bus Seat Backs

Whatever your product, if it's made of sheet metal, or could be, you'll *certainly* want to investigate the *tremendous* possibilities this revolutionary new Marvibond process offers. Better write to us for more information today!

*Pat. applied for

50TH ANNIVERSARY 1904 1954 NAUGATUCK CHEMICAL

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Division of United States Rubber Company

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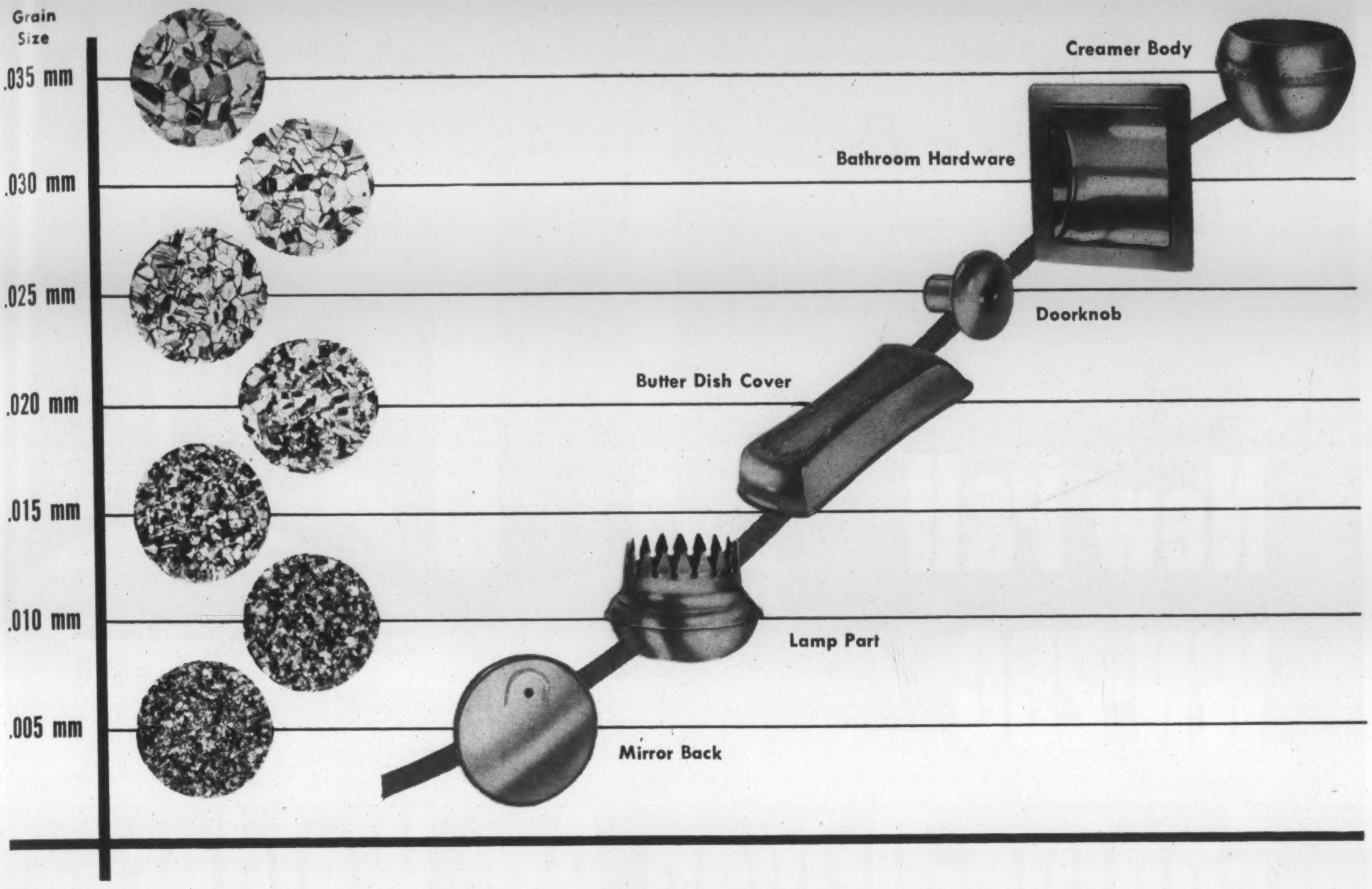


Which is the RIGHT Fine Grain Brass for a Job!

the 4th DIMENSION
BRIDGEPORT BRASS COMPANY

Write for a free copy of Bridgeport's folder on Grain Size—"The Fourth Dimension."

High finish on decorative brass can be produced at much lower cost by using a fine grain metal. But severe cupping, drawing and forming operations require ductility which decreases, generally, as grain size gets finer.

The right metal for the job, then, is often a compromise between fineness of grain and ductility: *no one fine grain brass can do all jobs well.*

By offering a *range* of grain sizes, Bridgeport can supply you with the *right* fine grain brass for every application, assuring you optimum production at lowest costs.

Bridgeport Technical Service will be glad to work with you in finding the right brass for your product if you will contact them through your local Bridgeport Sales Office.

BRIDGEPORT BRASS

COMPANY ◆ BRIDGEPORT, CONNECTICUT

Serving Industry With a Nationwide Network of Conveniently Located Sales Offices and Warehouses
Mills in Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich.
In Canada: Noranda Copper and Brass Limited, Montreal

For more information, turn to Reader Service Card, Circle No. 446

NEMA-rated at 200 amps.
—but pulls 300 amps.!
Runs all day on one tank of gas!

P&H ARC WELDER

Both engine and generator are mounted on a sturdy frame. Two-wheel mounting also available.

New P&H WN-250 Engine-Driven Arc Welder

Here you get everything you've ever wanted in an engine-driven welder — including cost-cutting features you don't get from any other:

(1) The P&H WN-250 has more capacity than other welders with the same rating.

(2) It has a full 20-gallon gas tank.

(3) It is powered by a direct-connected 180GLU Waukesha gasoline engine, water-cooled and built for heavy duty. Not an automotive light-weight. Available with electric starter.

(4) P&H idling device establishes the rated speed of 1800 rpm as soon as the arc is struck. This speed is maintained for a set period after the arc is broken.

(5) P&H Dial-lectric Control provides stepless heat adjustment over the entire high or low range.

(6) It has pre-lubricated bearings, to reduce the need for servicing and insure longer life.

(7) Auxiliary AC power supply (1KVA) permits floodlighting and running power tools.

You're money ahead with a P&H WN-250. Ask your P&H representative or distributor for all the facts. Or, write for bulletin.

P&H WELDING DIVISION
HARNISCHFEGER CORPORATION
4550 West National Avenue
MILWAUKEE 46, WISCONSIN

Continuous 8-hour welding test demonstrates the extra stamina of the P & H WN-250

You can't beat welding performance like this: In a recent test, the P&H WN-250 operated continuously for 8 hours on a 70% duty cycle.

A 5/32" electrode was used with 300 feet of cable. There were 250 amps. at the electrode. So that test would be continuous, three welding operators were used. When one got tired, another took over. All used the drag technique with a 6010 rod—which is as close to a short circuit as you can get.

At the end of 8 hours, the P&H generator was still cool. And the WN-250 was still rarin' to go—the weldors were worn out, but not the machine.

the **P&H** *Line*

TRUCK CRANES · DIESEL ENGINES · POWER SHOVELS · PREFABRICATED HOMES · ELECTRIC HOISTS · SOIL STABILIZERS · WELDING EQUIPMENT · OVERHEAD CRANES

25958

For more information, turn to Reader Service Card, Circle No. 388

FASTER, LOWER COST **Hardening**

FOR ALL **Engineering Steels**

No other device approaches Ajax neutral salt bath efficiency in hardening steels . . . low carbon, high alloy, stainless, high-carbon high-chrome, high speed types . . . *because only Ajax protects the work so effectively from atmospheric effects.*

All air is "sealed out." A film of salt protects the work up to the instant of quenching . . . keeps the surface clean. Scaling, pitting, carburizing and decarburization are avoided.

LOW COST — First cost of equipment is only ½ to ⅕ that of any other production hardening system!

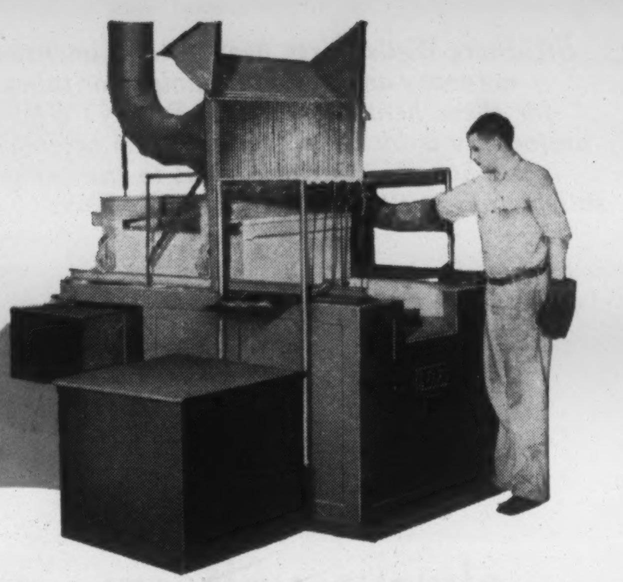
RAPID HEATING—Heating cycles from 4 to 6 times faster than in radiant type furnaces assure greater production in less time. Distortion is negligible.

UNIFORM RESULTS—*Uniform* physical properties result from *uniform* bath temperatures . . . and, in the Ajax furnace, a temperature variation of less than 5°F is held throughout. Smaller equipment in less space produces a given output. Unskilled labor can handle the entire process.

ADAPTABILITY—Selective heating is easily obtained by immersing only that portion of the work to be hardened. A unique method for hardening gear or sprocket teeth is to spin them in salt, immersing only the teeth.

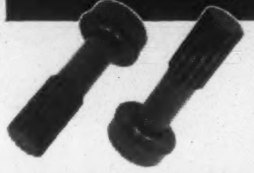
WRITE FOR Ajax Catalog 116B, also list of documented case histories of hardening installations.

SEND your specimen parts to the Ajax Metallurgical Service Laboratory for treatment. No cost or obligation.



Full hardness with no decarburization (even under microscopic examination) of silicon-manganese steel gears is obtained by a machine tool producer in this Ajax salt bath installation.

Fast COMPLETELY MECHANIZED HARDENING

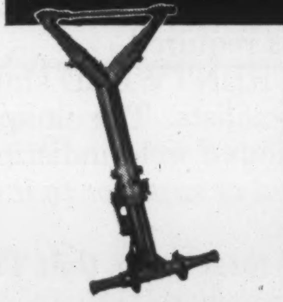


4-pound spline shafts loaded 4 shafts to a fixture, and up to 10 fixture loads at a time, are hardened at 1550°F. in a mechanized Ajax salt bath furnace. They are automatically quenched in water followed by a nitrate salt draw at 600°F. The Ajax furnace has operated day in and day out 24 hours a day for over a year without interruption.

5400 BLADES A Day

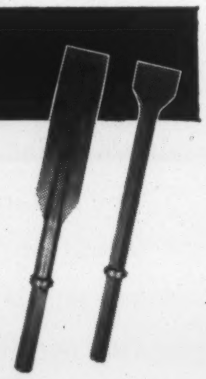
Good carving knives need exceptionally hard, tough cutting edges . . . and these blades of 440 stainless steel have them! 150 lbs. of work per hour, or 5400 blades per day, are handled in a single Ajax salt bath furnace by one unskilled operator.

MORE WORK IN Less Space



Aircraft landing gears of SAE-4340 steel up to 62" long are hardened in Ajax salt bath furnaces by immersing them vertically in baths 75" deep. Over 800 pounds of work are processed per hour . . . Great space savings afforded by treating pieces vertically. Austenitizing furnace, requires less than 70 square feet of space.

No Rejects



On a run of 30,000 rock bits hardened with Ajax salt bath furnaces, not one was rejected. Bit life was increased 4 to 5 times by comparison with a previous hardening method. Plain carbon steel rather than costly alloy steel is used . . . 480 lbs. an hour are treated in a bath with working dimensions of only 36" x 11" x 36"! Hardness never varies more than 1 point from Rc52.

AJAX
HULTGREN
Trademark.
electric SALT BATH furnaces

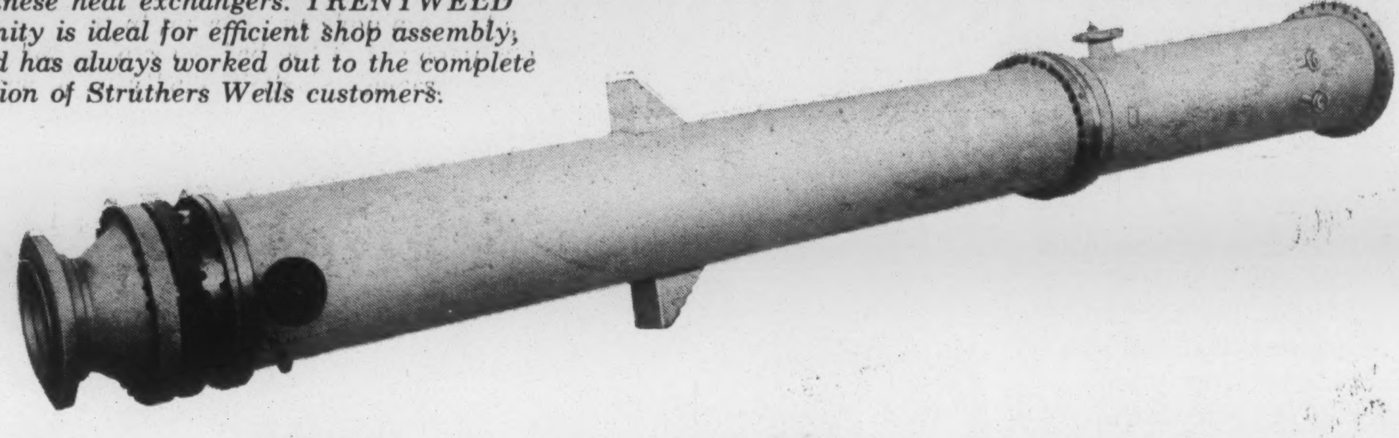
World's largest manufacturer of electric heat-treating furnaces exclusively

AJAX ELECTRIC COMPANY 906 Frankford Ave., Philadelphia 23, Pa.

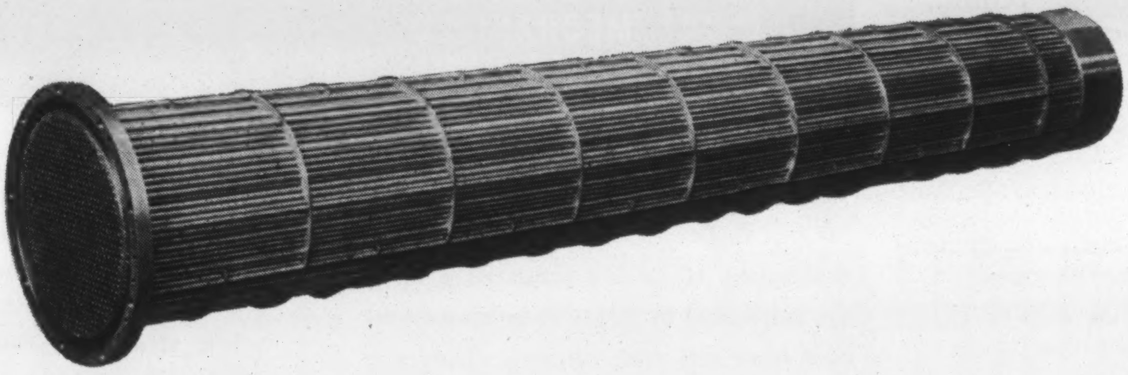
Associate companies: Ajax Electric Furnace Corp.; Ajax Engineering Corp.; Ajax Electrothermic Corp.
In Canada: Canadian General Electric Co. Ltd., Toronto, Ont.

For more information, turn to Reader Service Card, Circle No. 336

Struthers Wells Corp. needed top dimensional accuracy and material quality for tubes for these heat exchangers. TRENTWELD uniformity is ideal for efficient shop assembly, and has always worked out to the complete satisfaction of Struthers Wells customers.



always uniform . . . extra quality . . . largest selection



TRENTWELD stainless tubing

It takes *specialists* to manufacture stainless welded tubing of uniformly high quality. That's why TRENTWELD is the *preferred standard* for quality wherever stainless or high alloy tubing is required.

For TRENTWELD stainless tubing is the product of tube mill specialists. The unique Trent process results in a *uniformly sound* weld indistinguishable from the parent metal—*and equal or superior to it in strength, ductility and corrosion resistance.*

Don't forget, too, that Trent offers you the widest size range found anywhere. ⅛″ to 40″ O.D. are standard sizes...and even larger diameters are available if you need them.

So, whether you need stainless tubing for heat exchangers or kiln dryers...fountain pens or frying pans—*for any requirement* for stainless or high alloy tubing—remember: *you can't buy better tubing than* TRENTWELD.

FREE – ask for your copy of the new book "Trentweld Stainless and High Alloy Tubing." You'll find practical details on applications, plus full tables on physical and chemical properties, and weights per foot on the sizes and grades you need. Send for your copy today.

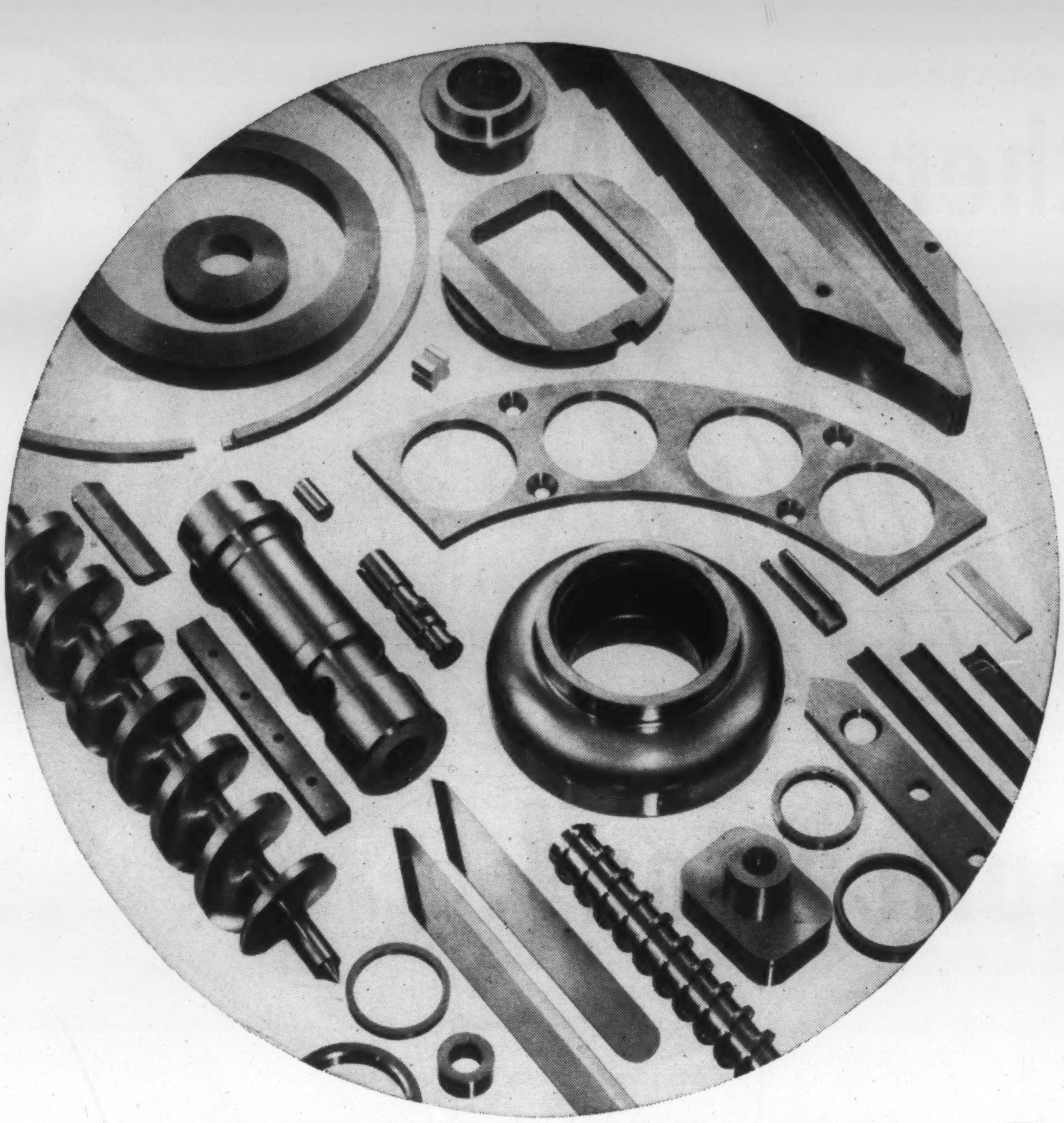
Buy
U.S. Savings
Bonds

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

For more information, turn to Reader Service Card, Circle No. 368



Some typical parts produced from Haynes alloys

Custom Tailored to cut maintenance costs

Alloys for Every Wear Condition Shaped to Your Specifications

Haynes alloys are available in a wide range of properties. They can be supplied as castings, forgings, stampings, or fabricated parts finished to close tolerances and with a mirror-like finish where required.

Some Haynes alloys are extremely hard—to resist severe abrasion. Some are tough and ductile, designed for use where mechanical shock or repeated stress cause ordinary metal parts to crack and splinter. Some resist the corrosive action of acids, alkalies, and molten metals. Erosion from steam or liquids, the softening effects of high-temperatures, seizing and galling from metal to metal contact, are other severe conditions that can be effectively controlled through the use of Haynes alloys.

Send us a blueprint of one of your wearing parts and tell us about the conditions under which the part must operate. We are sure we can supply you with a Haynes alloy part "custom tailored" to solve your problem.

"Haynes" is a registered trade-mark of
Union Carbide and Carbon Corporation.

HAYNES
TRADE-MARK
ALLOYS

HAYNES STELLITE COMPANY
A Division of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

For more information, turn to Reader Service Card, Circle No. 401

Another RUBATEX SOUND Application!

SOUND
R
TEX
RUBATEX

Every day product designers and industrial engineers are finding new applications for RUBATEX Closed Cellular Rubber to cushion out sound and isolate vibration and shock.

The inert nitrogen, retained under pressure, within closed cells and sealed with tough, live rubber, team up to give RUBATEX double action "air-cushioning"— quick recovery from compression —ability to cushion out sound and soak up shock, again and again.

When you have a "sound" application — check the superior advantages of RUBATEX first!

For air that protects —use Rubatex!

Write for our latest catalog, Dept. MM-12, Great American Industries, Inc., Rubatex Division, Bedford, Virginia.

ALSO MANUFACTURERS OF VINYL SHEETS

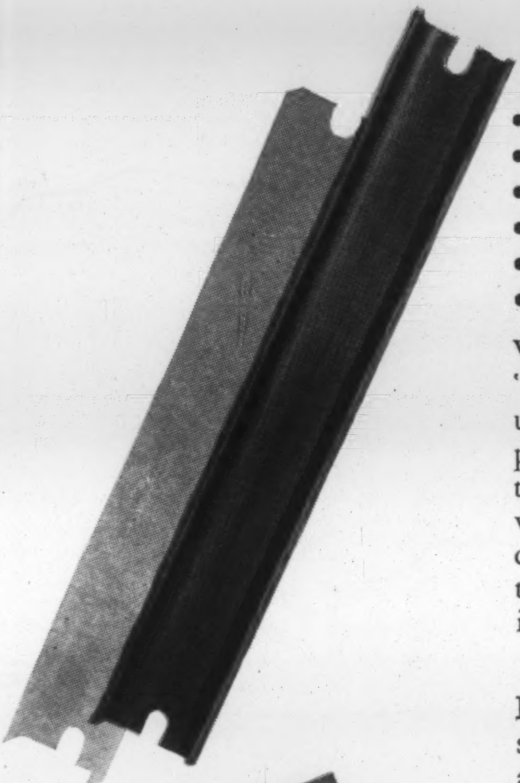
PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER ©

RUBATEX CLOSED CELLULAR RUBBER

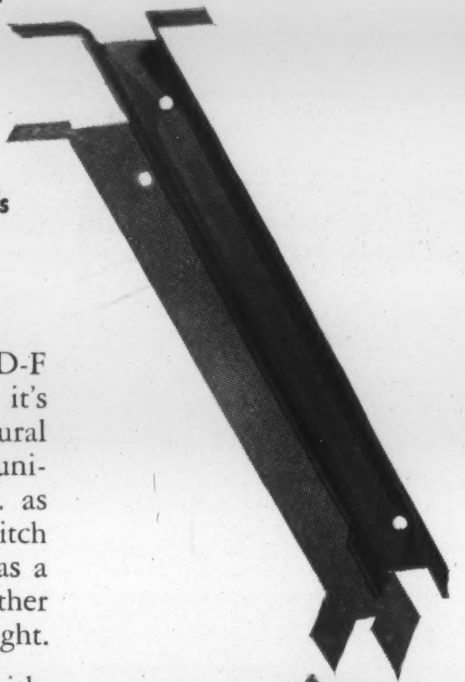
For more information, turn to Reader Service Card, Circle No. 310

EASY . . . INEXPENSIVE TO POST-FORM THESE PARTS WITH

New DILECTO CF-1

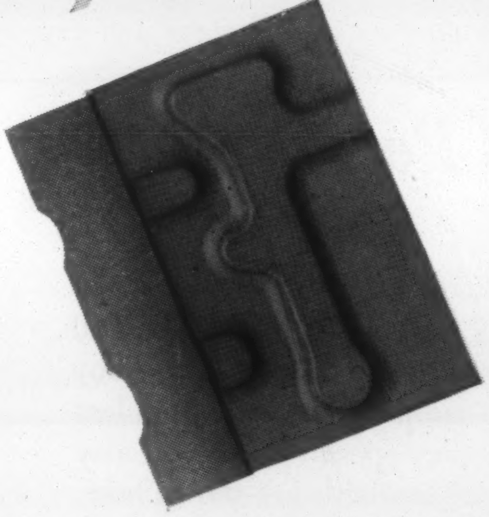


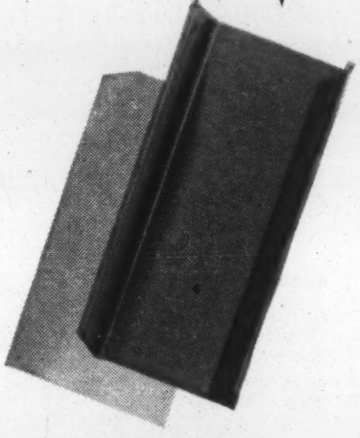
- *Non-After-Glow characteristic*
- *A canvas-based laminate*
- *Post-Forms to shapes in inexpensive cold molds*
- *Excellent mechanical strength*
- *Resists abrasion, has long life*
- *Easily machined and punched*



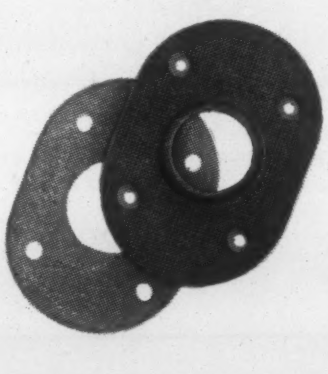
Where can you use this new canvas-based C-D-F "Post-Forming" Dilecto grade CF-1? Presently it's used for a multitude of aircraft and semi-structural parts . . . as ribbed panels, fan blades and ammunition bay liners, guards and cover frames . . . as ventilating ducts, battery box containers . . . switch covers, thermostat mounting plates, etc. CF-1 has a tremendous potential in electrical as well as other industries because of its strength and light weight.

"Post-Forming" Dilecto CF-1 is easy to work with. Heated until pliable with infra-red, electric ovens, strip heaters or hot plates, or immersed in molten alloys or hot oil, it is then quickly placed in a cold mold and pressed or formed until cold enough to retain the desired shape. Inexpensive molds can be made from hard wood, cast or laminated plastics, steel and metal alloys. Normally C-D-F supplies Dilecto CF-1 in sheets from 1/32" to 1/4" thicknesses.





C-D-F's sales engineers (offices in principal cities) will cooperate with your designers and production experts. C-D-F also forms and fabricates Dilecto to your specifications. Write for technical bulletins describing Dilecto CF-1 as well as other grades of Post-Forming Dilecto.



NON-AFTER-GLOW — Post-Forming Dilecto CF-1 incorporates special chemicals in the varnish that produce no apparent after-glow once an ignited specimen has been extinguished. This product complies with the SAE-Aeronautical Material Specification AMS-3605, latest revision.

SILICONES, TOO — C-D-F offers other post-forming grades of laminated Dilecto: Grade GB-SF is a glass-base Silicone laminate furnished in a semi-cured state for forming pieces where high heat resistance and low dielectric losses are required. Can be formed into armature slot insulators, rectangular coil forms, primary-secondary cylindrical or rectangular insulators for dry type transfomers, etc. Grade XF Dilecto is a paper-base grade for mechanical applications where electrical properties are secondary.

THE NAME TO REMEMBER CDF FOR POST-FORMING DILECTO LAMINATED PLASTICS

Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 25, DELAWARE

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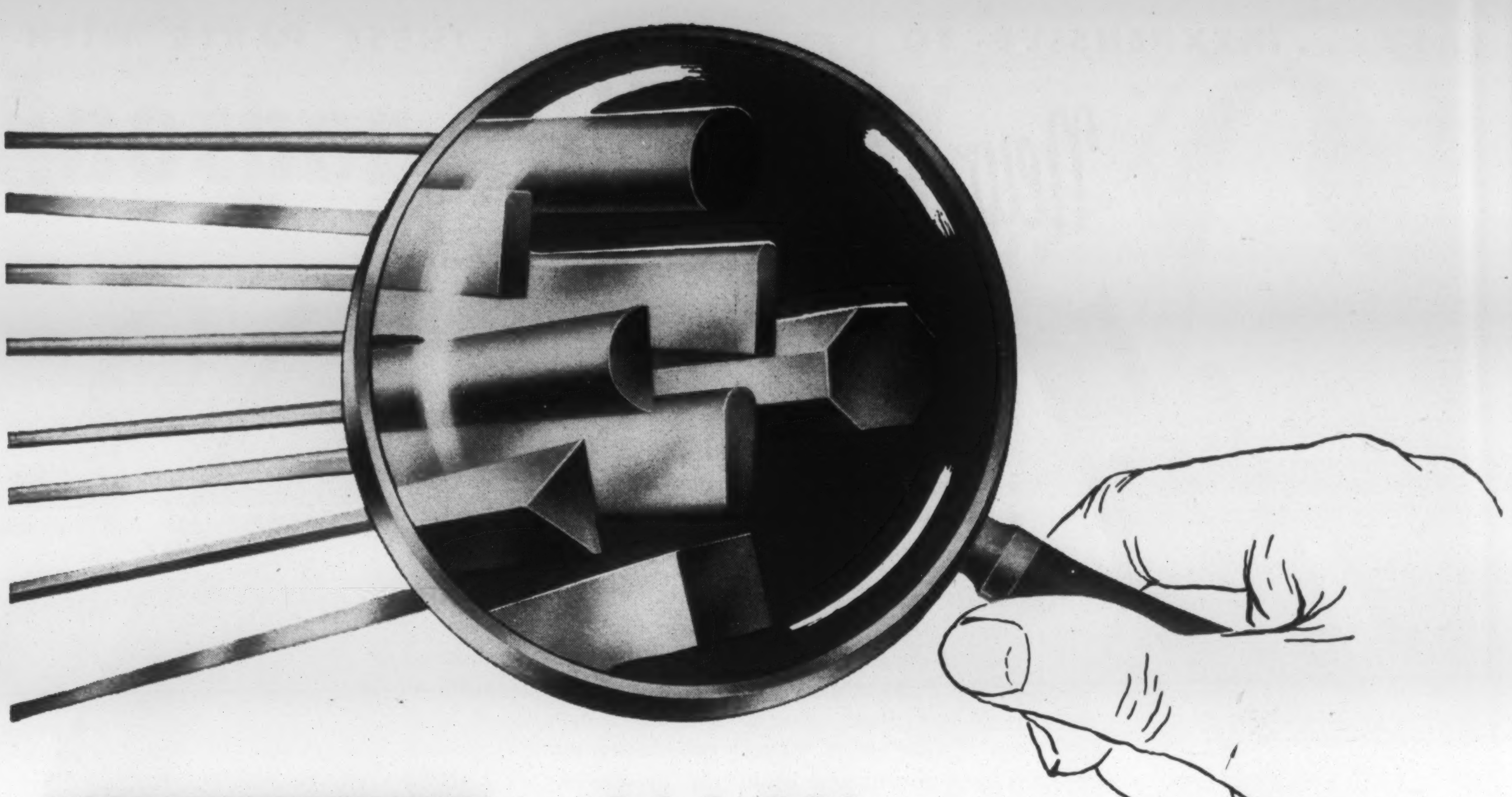
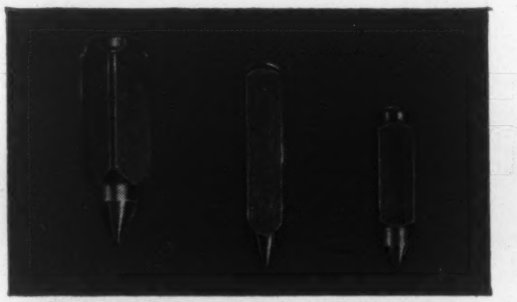
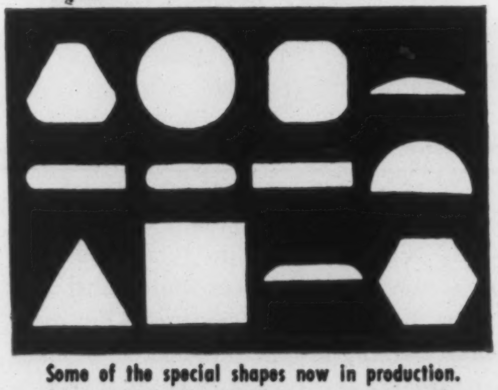




Pre-drawn shapes, such as triangles and squares, are naturals for carburetor needle valves.

Hex-head bolts and flat-wire lock washers take advantage of the material savings of special shapes.



Some of the special shapes now in production. Others can be developed to meet your needs.

ALLOY

Special Wire Shapes

CUT COSTS

Improve Product Performance

Alloy Special Wire Shapes eliminate costly machining time and cut metal waste. No need to start with round wire and then machine half of it away to get the shape you want. Alloy Metal Wire Division is ready to supply you with Stainless and Nickel Alloy wire in just about any special shape you may require. Some of the standard shapes available are shown here. We will be more than willing to work with you in the development of any other shape.

Drawn Alloy Wire Shapes provide other advantages in addition to reduced costs. Product quality and performance are also improved. The drawn wire insures uniformity of cross-section and a smooth, flaw-free surface.

For more details on Alloy Special Wire Shapes or for information on Stainless, Nickel Alloy or Electrical Resistance Wire, Rod and Strip, drop us a line. We are happy to be of service to you.

"Quality Products since 1919"

ALLOY METAL WIRE DIVISION

H. K. PORTER COMPANY, INC.
of Pittsburgh
PROSPECT PARK, PENNSYLVANIA

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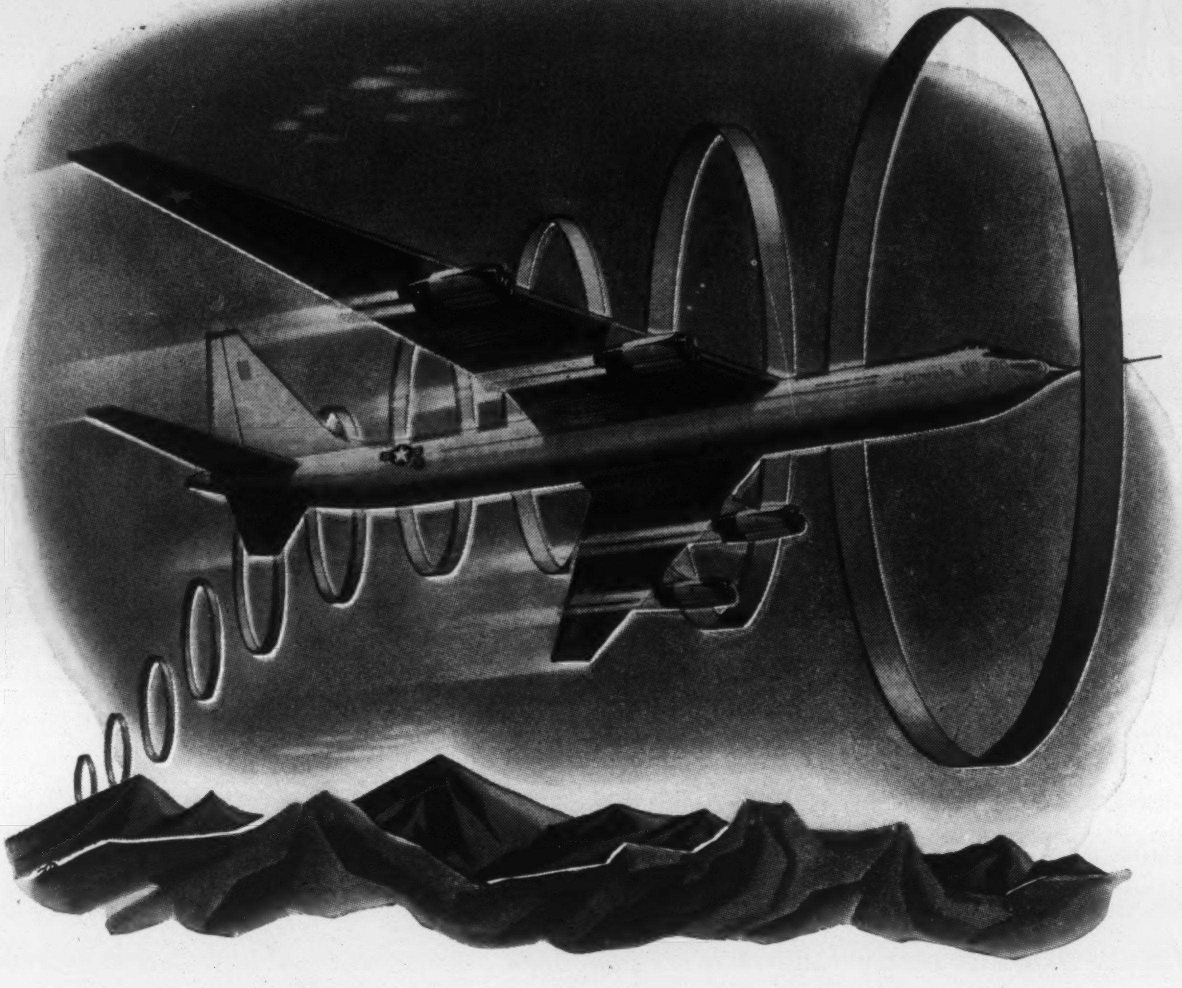

73 American Welded parts

IN EVERY J-57 JET ENGINE

For 35 years American Welding know-how has kept pace with the aviation progress. Today a large part of our extensive welding, machining and fabricating facilities are devoted to the production of welded components for U. S. jet engine manufacturers — 73 different kinds of parts on the Pratt & Whitney Aircraft J-57 turbojet alone.

This knowledge of welding and fabricating has also been applied to other industries. For example, if you produce a component like those shown here — or if you think fabrication by welding may be the solution to a particular problem —let us know. Our Product Development Division has been able to assist many companies with their metal fabricating problems and will be glad to consult with you.

THE AMERICAN WELDING & MANUFACTURING CO.
300 DIETZ ROAD • WARREN, OHIO

AMERICAN WELDING

WELDING • MACHINING • FABRICATING

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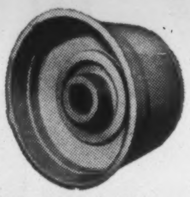
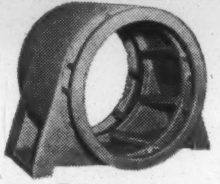
Tire Bases

Steel bands formed and flash butt-welded into wheel tire base for industrial trucks.



Wheel and Rim Assemblies

Weldment of carbon steel bar and plate for use on heavy earth-moving equipment.

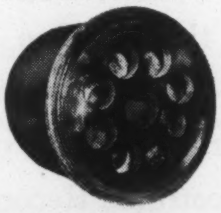


Motor Frames

Steel bars and plate formed and welded into industrial motor frame.

Compressor Cases

Welded band for hermetically sealed refrigerator compressor.

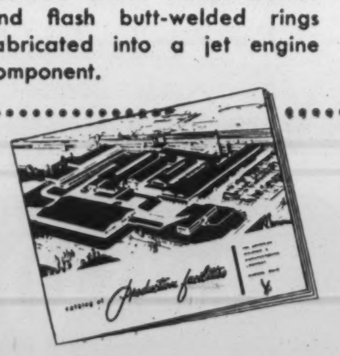


Armature Spiders

Weldment of six parts combining plate and bar stock.

Turbine Frame Assemblies

Formed sheet metal bands and flash butt-welded rings fabricated into a jet engine component.



Send for Free Catalog of American Welding Facilities

a new "low" in low capacity testing

with an Olsen Electronic Load Cell

...measures loads as low as 1 gram accurately

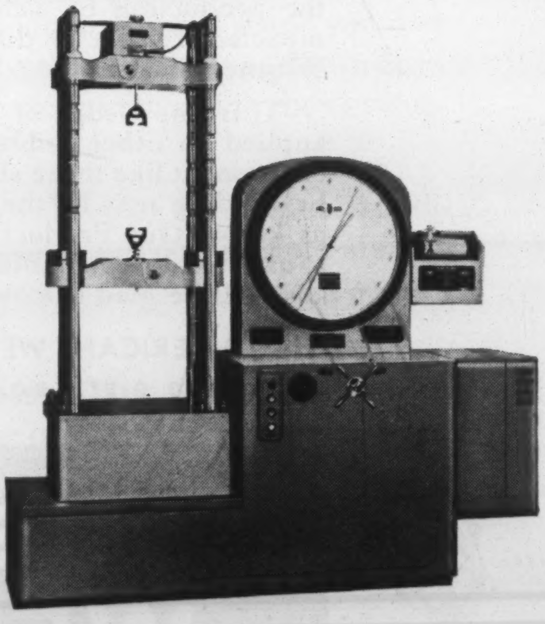
Any Tinius Olsen Super "L" or ElecTOmatic Universal Testing Machine can be used for extremely low capacity testing with the addition of a low cost Electronic Load Cell. Simply tighten one wing nut and plug in an electric cord . . . and your Olsen is ready for low capacity tension, compression or transverse testing of fabrics, wire, plastics and many other materials. With the flip of a switch, either of two capacity ranges are at your command—0 to 1200 grams or 0 to 6000 grams. The applied load, from 1 gram to the capacity of the machine, is indicated accurately on the large, 28-inch diameter SelecTOrange dial, and stress-strain curves can be produced automatically on an Olsen Electronic Recorder.

The Olsen Electronic Load Cell adds greater flexibility to your testing program . . . eliminates the need for a special machine for low capacity testing. An auxiliary indicating unit is available which permits use of the Olsen Electronic Load Cell with any conventional testing machine.

For details about low capacity testing with an Olsen Electronic Load Cell, write today to Tinius Olsen.

1 GRAM to 30,000 LBS.

Equipped with an Olsen Electronic Load Cell (upper crosshead) this 30,000 lb. capacity ElecTOmatic U.T.M. accurately indicates loads from 1 gram to 30,000 lbs.



TINIUS OLSEN
Testing & Balancing Machines

TINIUS OLSEN
TESTING MACHINE CO.
2010 Easton Road · Willow Grove, Pa.

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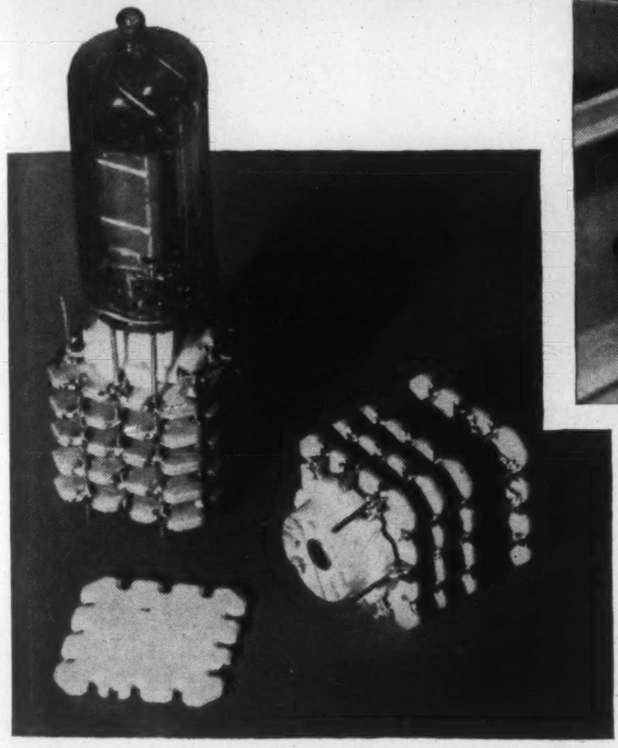
Another Norton ℞ on the job!

On Project Tinkertoy, ceramic wafers containing barium titanates are fired at 2600°F. The ℞ for this job is setter plates of Norton FUSED STABILIZED ZIRCONIA. These plates *engineered* to withstand the effects of the very reactive titanates and to make repeated trips to the electric furnace for 9-hour firing cycles — have proved to be most practical for firing titanates.



◀ *Completed Modules* made entirely automatically by the Tinkertoy process, with a ceramic wafer containing titanates ready for firing on Norton FUSED STABILIZED ZIRCONIA setter plates.

Project Tinkertoy,† *revolutionary method of producing electronic circuits, uses Norton setter plates*

Project Tinkertoy, developed by the National Bureau of Standards and sponsored by the Navy's Bureau of Aeronautics, is designed to produce complete electronic units automatically. The Project is in full swing at a pilot plant in Arlington, Va., operated for the government by the Kaiser electronics division of the Willys Motor Co. According to cost experts the new "push-button" method is cutting production costs approximately 40%!

Standard "building blocks" used in the new system are ceramic wafers, mechanically produced and assembled into modules, which replace the complicated mazes of wiring characteristic of conventional electronic equipment.

The Norton ℞ For Tinkertoy

Firing of the Tinkertoy ceramic wafers — in electric furnaces at 2600°F — is an important processing step. For firing wafers containing barium titanate elements, the refractory setter plates selected are made of Norton FUSED STABILIZED ZIRCONIA.

This Norton-developed refractory material has been especially *engineered* to provide inertness, cleanliness, and long life. It is *prescribed* for many similar applications to provide maximum efficiency at high temperatures.

For firing steatites, Norton prescribes CRYSTOLON* setter plates, a highly unreactive and oxidation-resistant silicon carbide refractory material. And for electric furnaces and kilns the ℞ is CRYSTOLON heating elements — "Hot Rods" — with a proved capacity for 2 to 4 times longer service life.

For further facts on the refractory materials *you* need to improve and economize your processing, call in your Norton Refractories Engineer. Or write direct for literature to NORTON COMPANY, 351 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto 5, Ontario.

NORTON

REFRACTORIES

Engineered . . . ℞ . . . Prescribed

Making better products . . . to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

†Now known as "Modular Design of Electronics and Mechanized Production of Electronics."

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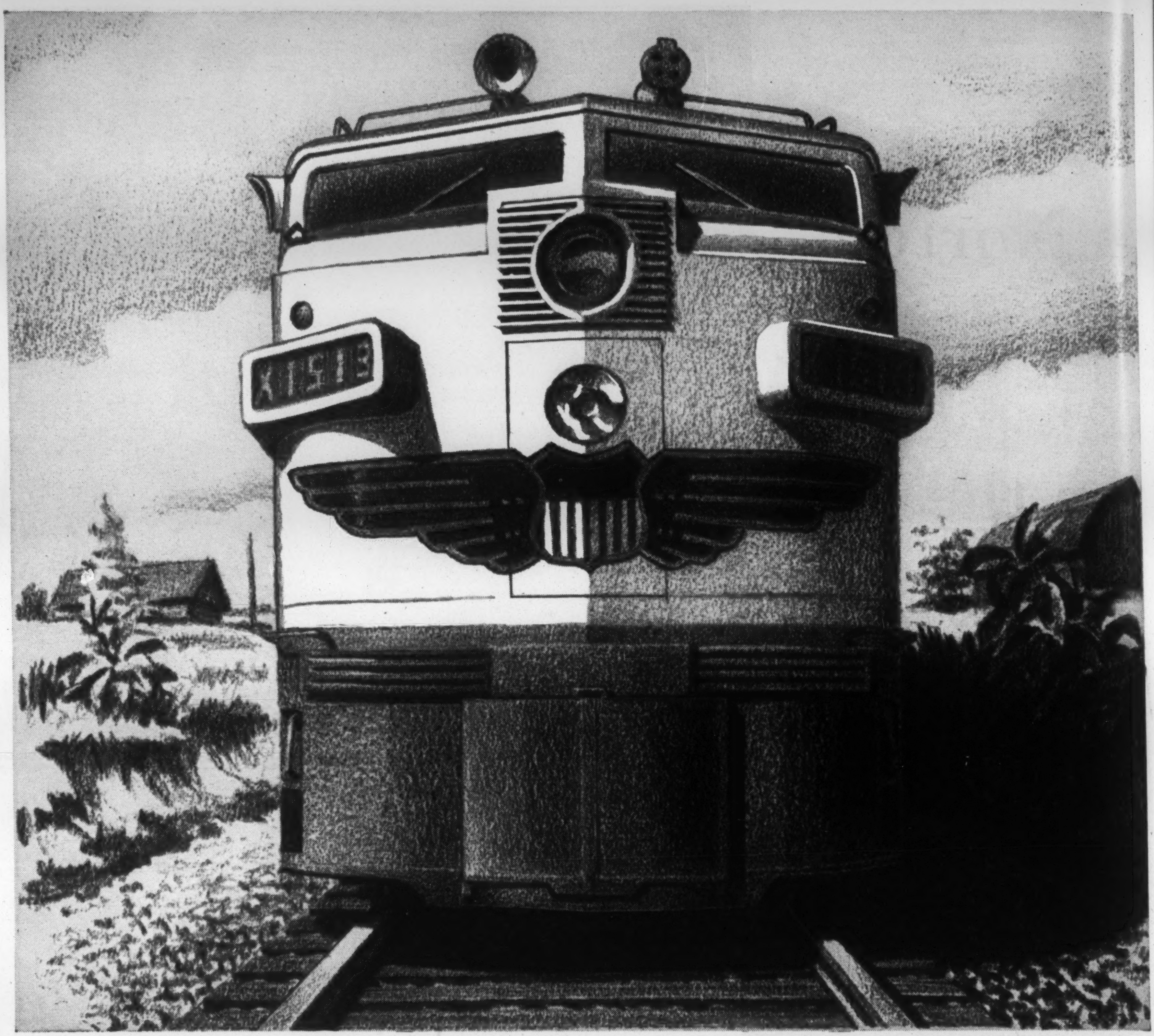


Here's where heat and corrosion prove metal...and metallurgists

For castings subject to High Fluctuating Temperatures . . .

Waukesha No. 321 Titanium Stabilized Stainless Steel

Supercharger inlet ports in giant railroad diesels demand castings of unusual characteristics. They must be high in corrosion resistance, and must maintain this resistance under abnormally high temperature fluctuations. In addition, close tolerances demand easy machinability.

This is the kind of problem that naturally comes to Waukesha Metallurgists for laboratory solution. Waukesha No. 321 Stainless Steel with *titanium*, with carefully controlled modifications, offered a solution. Its effective use in castings requires a high degree of knowledge and skill both in formulation and in production, but Waukesha has succeeded in casting it for such critical uses as trays and conveyor parts for heat treating furnaces and other high temperature needs. Its adaption to G-E Supercharger inlet ports is another example of Waukesha's experience in serving industry with the more difficult alloys.

Have You a Castings Problem?

Take this opportunity to prove Waukesha's advanced metallurgical service — to your profit! Send us a pattern for sample casting. Or write for booklets containing current data on Waukesha Stainless Steel and "Waukesha Metal".

call **Waukesha** *first . . .*

WAUKESHA FOUNDRY CO.

5403 LINCOLN AVE., WAUKESHA, WISCONSIN

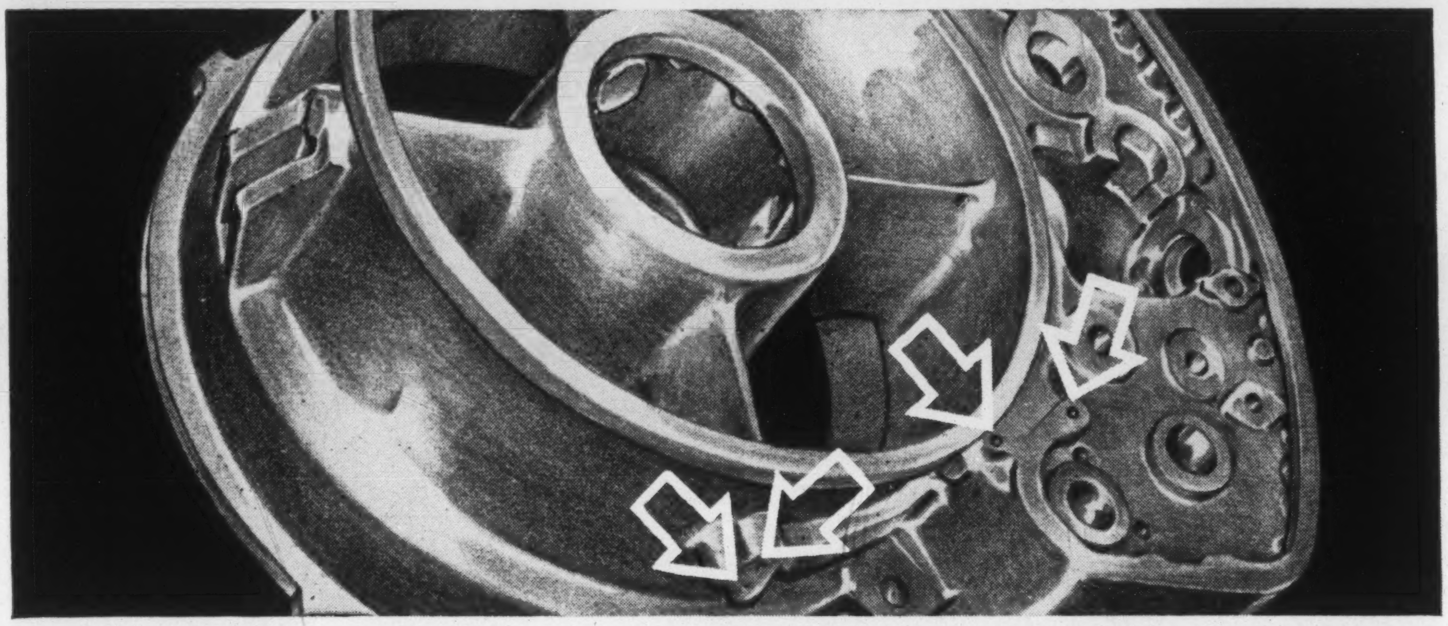
For Metallurgical Aid in Every Corrosion Resistant Alloy

For more information, turn to Reader Service Card, Circle No. 372

FIGHT WEIGHT WITH STRENGTH

WITH ROLLE

Whenever weight is a factor in your designs it pays to call on Rolle. Solving such problems from the development stage on up to delivery of the finished product has been Rolle's business for almost a quarter century. For whether you need aluminum or magnesium alloys, you can depend upon Rolle for an unbiased solution that combines the lightest weight, the greatest structural strength, and the highest quality for any given application.



A recent magnesium casting by Rolle, utilizing the Al-Fin process in which stainless steel tubing is integrally cast into the body of the casting.

Aluminum and Magnesium Castings

Rolle's complete foundry service for sand, permanent mold, and die casting covers free development service and quality control throughout production, *including quantometer analysis.* It covers, too, such special foundry services as *precision* sand casting . . . the pouring of Magnesium Elektron Ltd. cerium-zirconium-magnesium alloys and the Al-Fin process for bonding ferrous to non-ferrous metals, for which Rolle is licensed. From small castings up to the largest ever made, in shapes that often cannot be produced economically any other way, here is a foundry unmatched for its service to the aviation, electronics, and transportation industries.

Expanded Permanent Mold Facilities

Rolle's recently expanded permanent mold casting department stands ready to contribute the highly specialized knowledge of decades of permanent mold experience to your particular casting problems. Here is the most helpful way for you to take full advantage of the economies and performance available only through permanent mold casting. We would be happy to acquaint you with the type of work, both simple and complex, with which Rolle personnel are familiar.

For a free booklet that shows you how you can fight weight with strength with Rolle write Rolle Manufacturing Company, 301 Cannon Avenue, Lansdale, Pennsylvania.

ROLLE

MANUFACTURING COMPANY • Lansdale, Penna.

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Another new development using

B. F. Goodrich Chemical *raw materials*

Cutaway view of Victor K-4 molded seal showing unique design.

K-4 oil seals, made by Victor Manufacturing & Gasket Co., are installed on International Harvester trucks. B. F. Goodrich Chemical Company supplies only the Hycar rubber.

TRUCK SLOSHES THROUGH WATER SAFELY

...with Hycar bearing seals

THIS truck's front wheel bearings are fully protected from the water and dirt of this big puddle by seals made of Hycar rubber. And just as vital a function—the Hycar bearing seals keep grease in!

This double protection means double savings. These Victor seals made of Hycar assure the long life and efficiency of the wheel bearings. Costly repairs are eliminated because the bearings cannot run dry and foreign matter cannot score their highly polished surfaces.

Hycar rubber is used in many sealing applications — for trucks, passenger cars, tractors and home appliances. Hycar is highly resistant to abrasion and maintains a tight seal under severe operating conditions and a wide temperature range.

Parts made of Hycar can be molded to close tolerances. And—Hycar's resistance to oil, grease and most chemicals makes it ideal for many uses in many industries.

Perhaps Hycar can solve a problem for you—do a job that you thought couldn't be done. We'll help you find the answers—give you technical advice. For information, please write Dept. HR-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Hycar
Reg. U. S. Pat. Off.
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON colors

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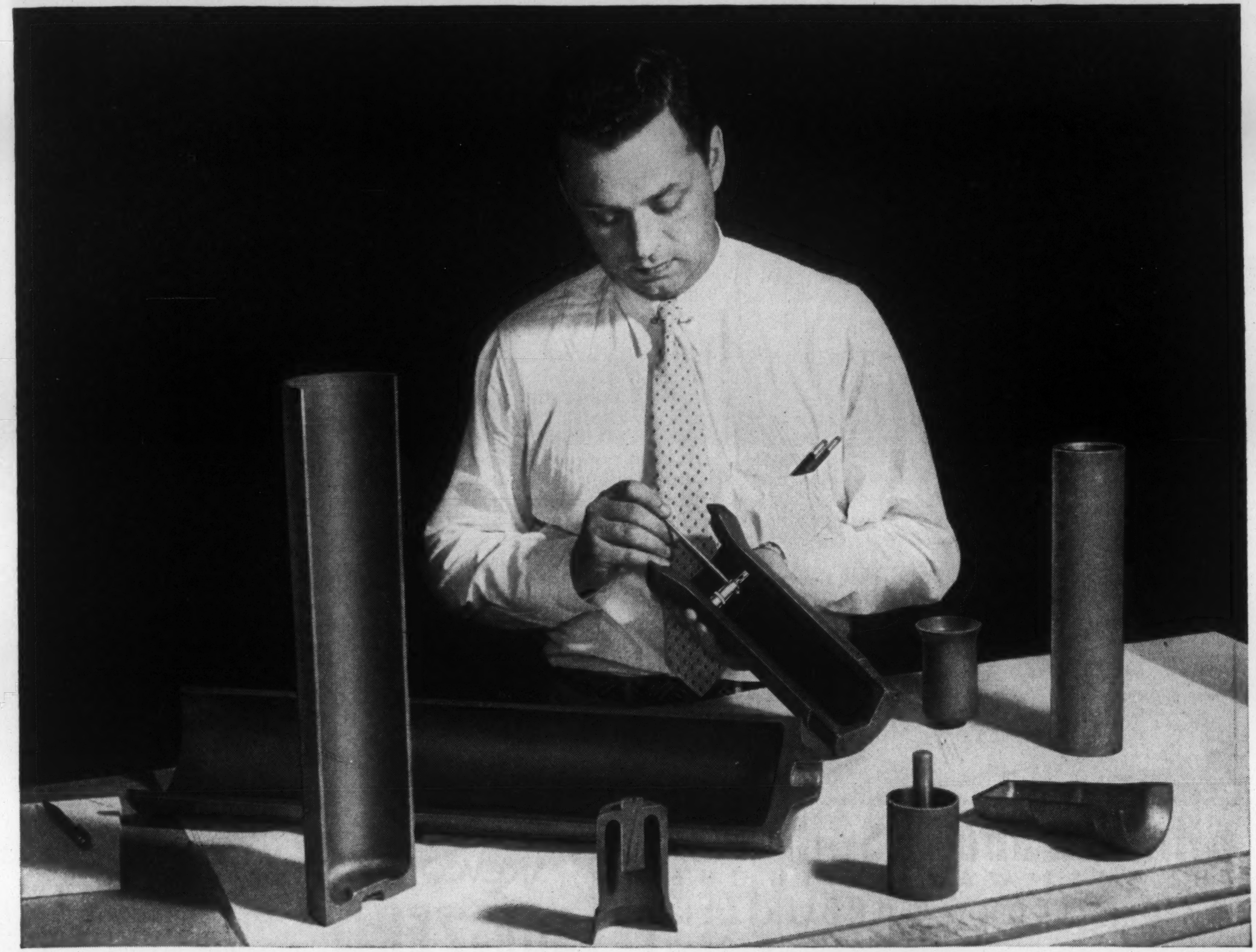
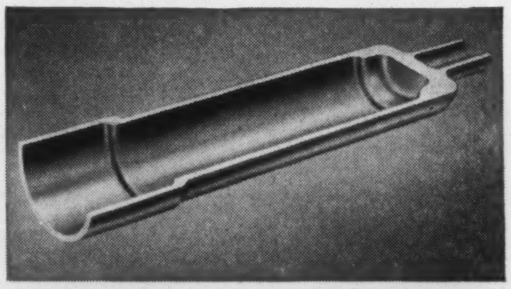
Extruded to finished dimensions!



Mullins Koldflo can mass produce steel parts like these with close tolerances . . . smooth surfaces . . . at lower cost



SPECIFICATIONS OF TYPICAL KOLDFLO EXTRUSION
Tractor power steering cylinder, length 16⅝ in.
Diameter 2.813 in., held to —.000 + .002 in.
Surface finish 60 microinches or better.

THESE one-piece parts are cold-extruded to precision dimensions, with no machining, grinding, or honing required. Thus, in volume quantities, the Mullins Koldflo* process can produce at far lower cost than other methods.

Mullins Koldflo permits you to design intricate cylindrical parts the way you want them. Design features such as shoulders, recesses, studs, etc., can usually be provided easily.

*Trade Mark

Let us quote on *your* parts . . . simply give us design details and specifications, and your quantity requirements.

Write or call the nearest Mullins office for engineering information. For copy of new booklet "How would you tool-up to make an egg?", write Koldflo Division, Mullins Manufacturing Corporation, Dept. C-12, Warren, Ohio.

Koldflo
DIVISION
MULLINS MANUFACTURING
CORPORATION
Warren, Ohio

Phone – 2-1166

DISTRICT SALES ENGINEERING OFFICES

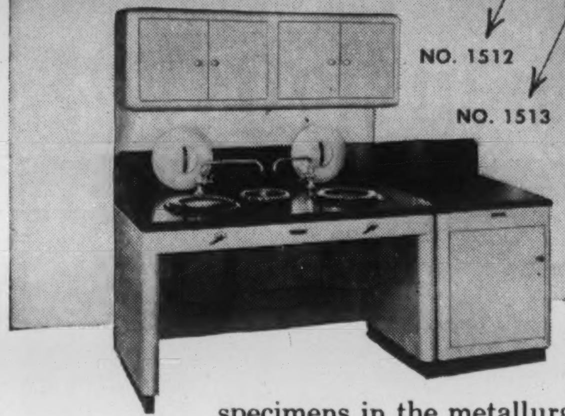
New York
500 Fifth Avenue
Phone—Pennsylvania 6-2773

Detroit
18268 James Couzens Highway
Phone—Diamond 1-1490

Chicago
332 South Michigan Avenue
Phone—Harrison 7-3725

For more information, turn to Reader Service Card, Circle No. 453

For more information, turn to Reader Service Card, Circle No. 389



BUEHLER POLISHING DESK

...with matching storage cabinet...

For maximum efficiency in the production of specimens in the metallurgical laboratory the Buehler cabinet type polishing table with companion storage cabinets represents the latest modern development of this type of equipment.

The convenience of this streamlined polishing equipment saves time and encourages the operator to produce the highest quality of polished sample.

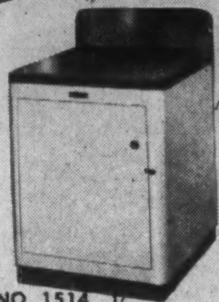
Item No. 1511 is a two-unit polishing table with Formica top approximately 60" long x 27" deep by 30" high to table top. Two 12" swing spouts, drain, 8" diameter wash bowl, plumbing and wiring.

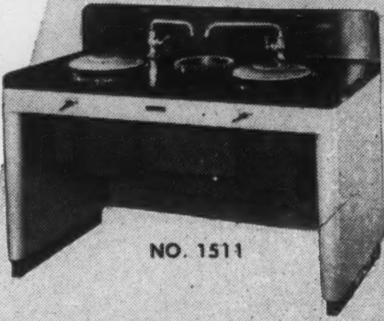
Recommended accessories to complete an efficient set up for maximum convenience are: No. 1512 storage cabinet with recessed light and No. 1513 supporting panel for installation above polishing desk. Or, No. 1514 floor model storage cabinet. Both these cabinets can be used together to advantage in most laboratories.

The Formica top and back on the table and cabinet is installed with a smooth Formica edge that eliminates all metal rims that may form pockets for water and dirt. Covers are held in place on the back by magnetic holders. The large 8" wash bowl is a new feature that enables the operator to use both hands in washing specimens.

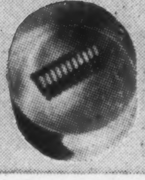
All metal construction finished in hammer tone grey makes a very attractive appearance. Prompt delivery can be made on these new items.

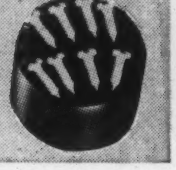
The Buehler Line of Specimen Preparation Equipment Includes . . . Cut-Off Machines Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives



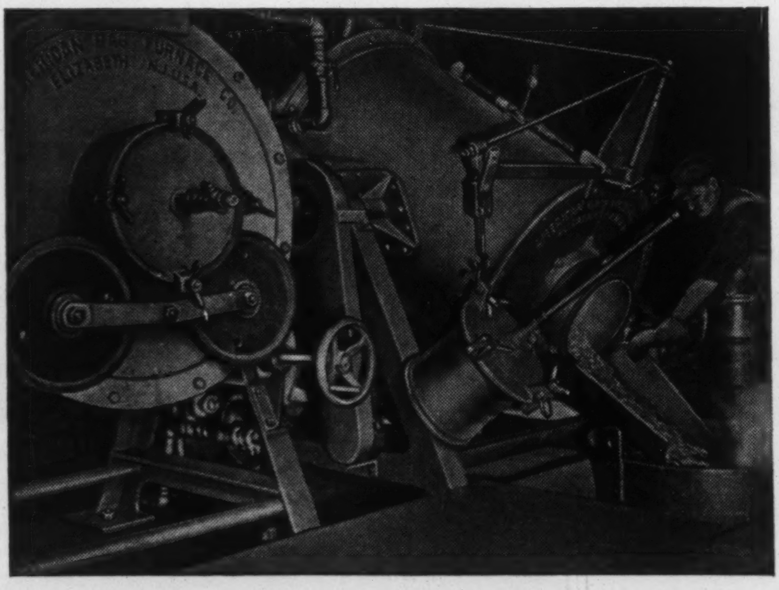


Buehler Ltd. METALLURGICAL APPARATUS
2120 Greenwood Avenue, Evanston, Illinois





CHARGE and DISCHARGE
THE EASY WAY—WITH THE
AGF ROTARY CARBURIZER



The AGF Model 2GA Rotary Gas Carburizing Furnaces are used very widely by makers of aircraft parts, small tools, arms, screws, nuts, bolts, ball bearing and precision parts requiring clean hardening, tempering, annealing—all or any phase of heat treatment. Easy to control.—Easy to load and unload.

Write to the PIONEER makers of gas furnaces and equipment

AMERICAN GAS FURNACE CO.
1008 LAFAYETTE STREET, ELIZABETH 4, N. J.

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Revco

SUB-ZERO CHESTS

Temperatures as low as -95°F BELOW ZERO

•

For Shrink Fits
Seasoning Gauges
and Precision Tools
For Laboratory Tests

•

REVCO RIVET COOLER *Shown with 90 Rivet canisters...* **Model RSZ-503**
Special Equipment Added To Meet Customer Requirements, if desired.

MODEL	CU. FT.	TEMP. PULL DOWN 70° RM	CAPACITY Inside (")			OUTSIDE Dimen. (")			Hermetic UNITS*
			L	W	H	L	W	H	
RIVET COOLER RSZ-503	5.0	−30°F	30	16	18	42	28	41	¼ HP
SUB-ZERO SZH-153	1.5	−95°F	23	9	12½	42	28	43	¾ & ¼
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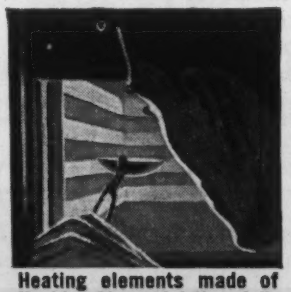

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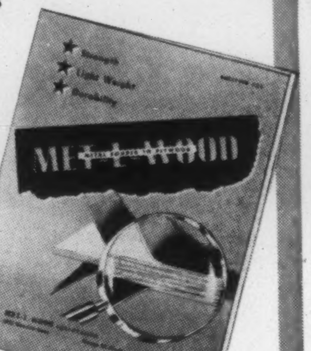

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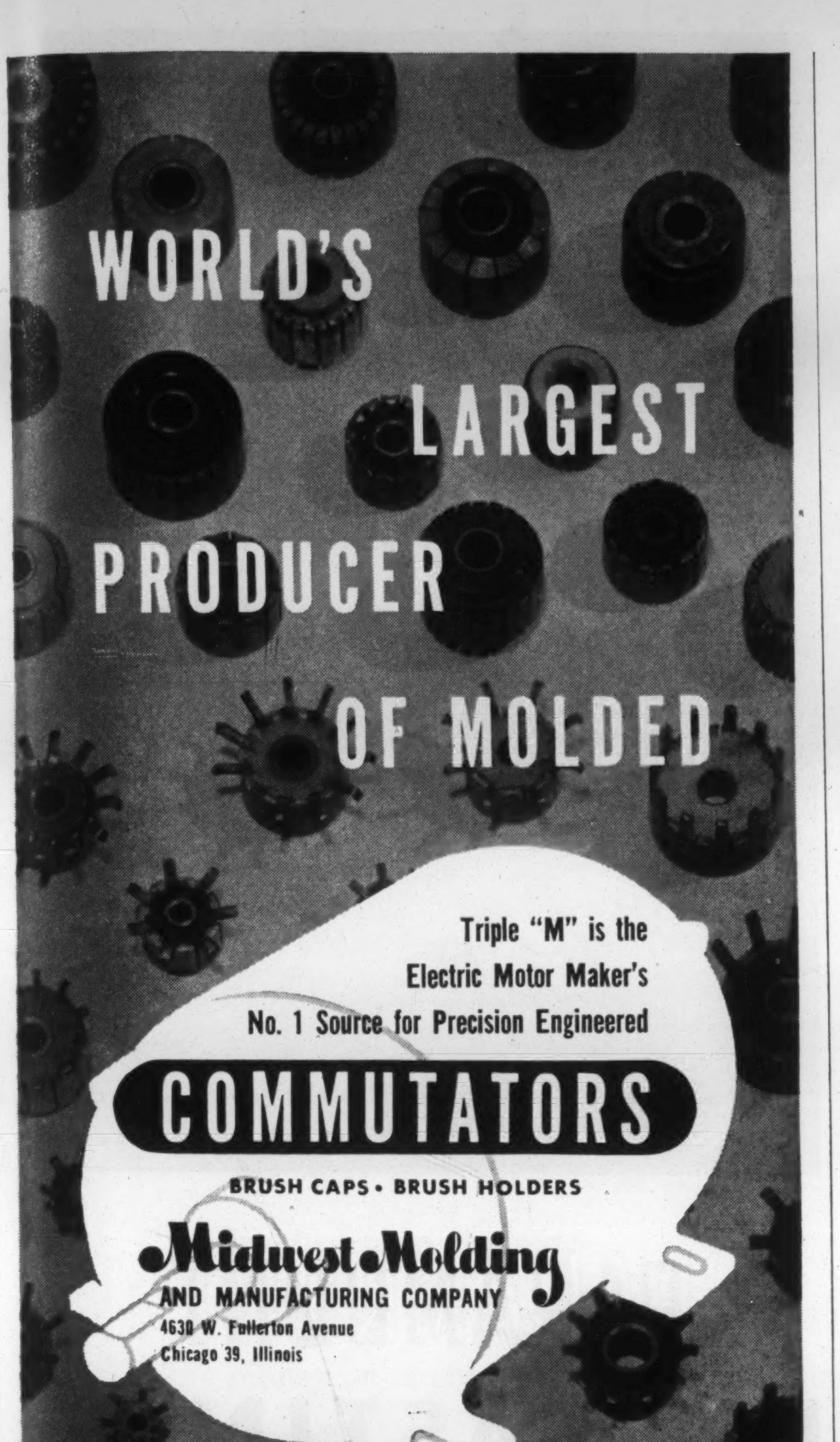

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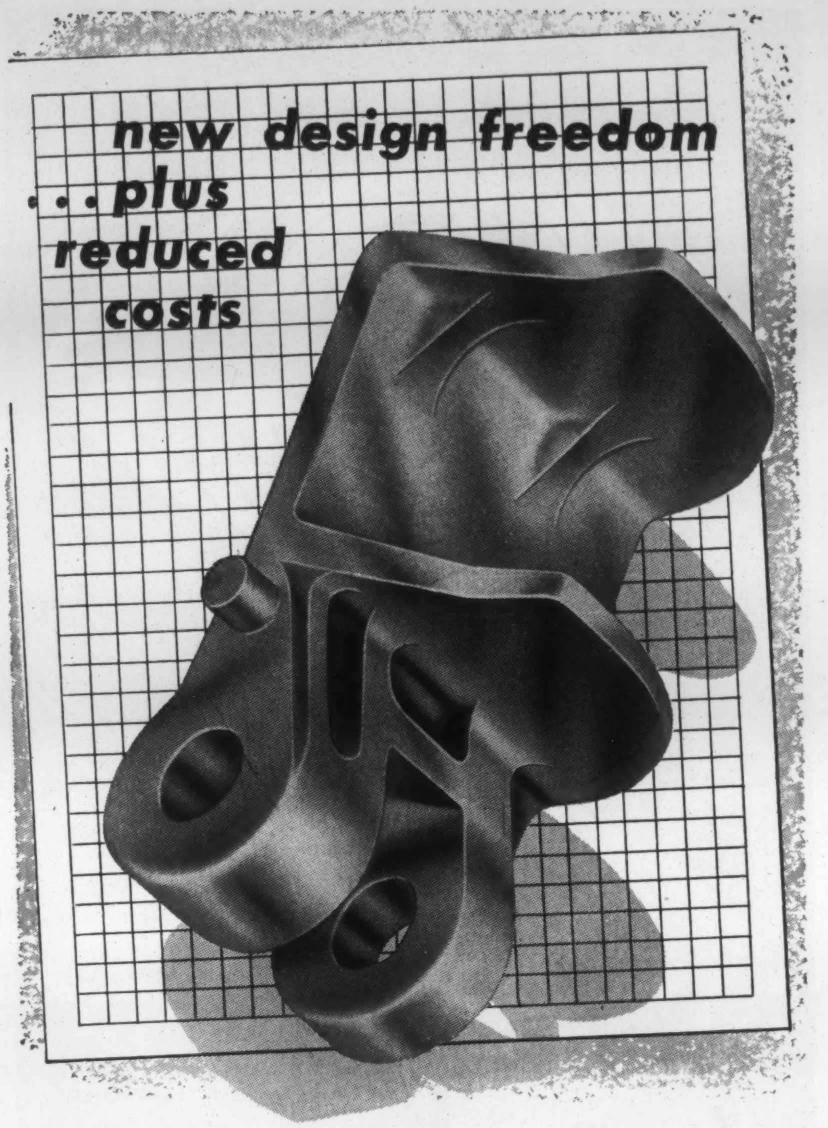

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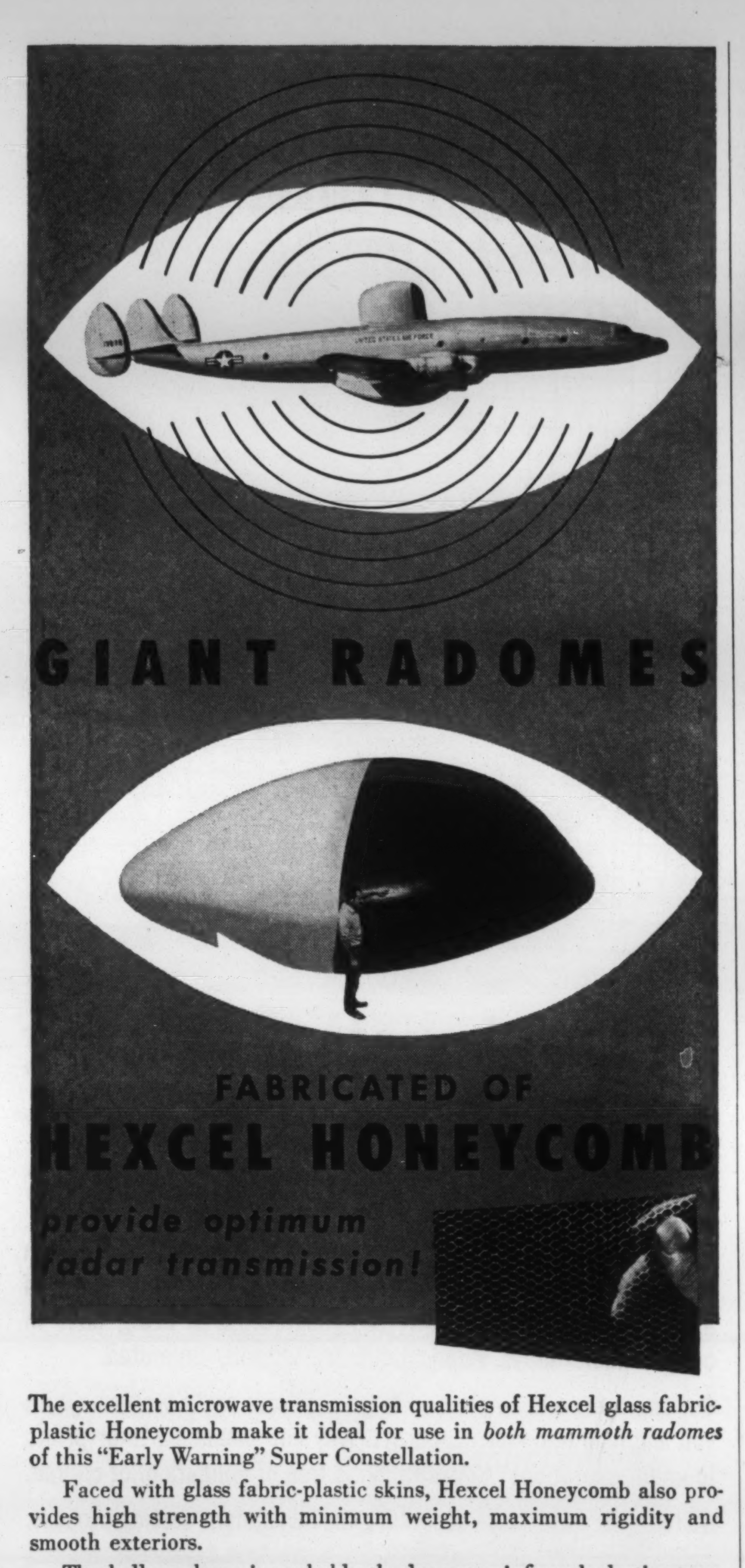

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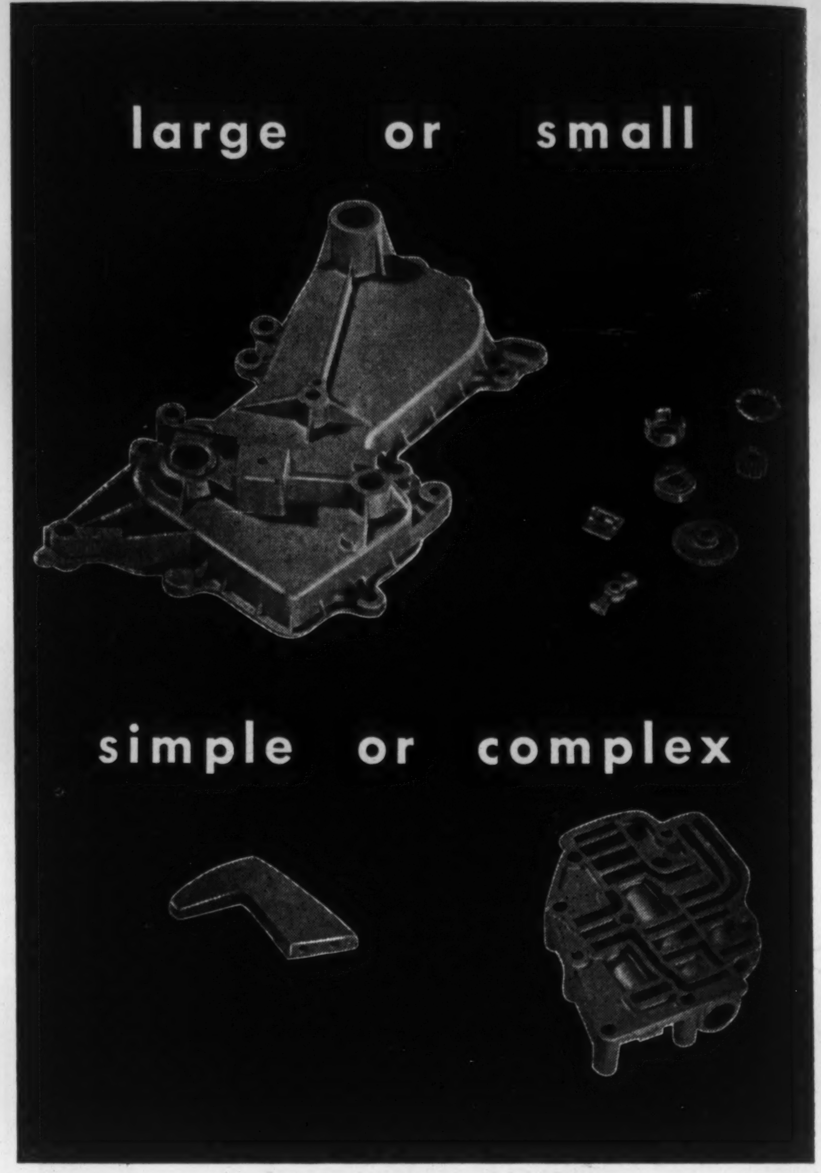

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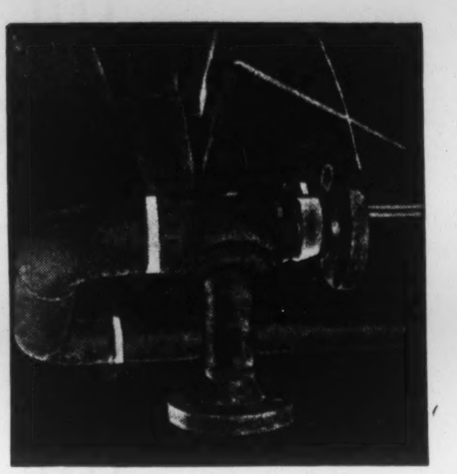
Agency—John W. Odlin Co., Inc.

Youngstown Sheet and Tube Co. 227
Agency—Griswold-Eshleman Co.

Zirconium Metals Corp. of America 223
Agency—Comstock & Co.



Use

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

RADIUM

for the tough weld inspection jobs

because radium-radiographing equipment is

1. **Portable**
2. **Easily handled**
3. **No training needed to operate**
4. **Economical**

●

For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

Write today for case histories and additional information.

●

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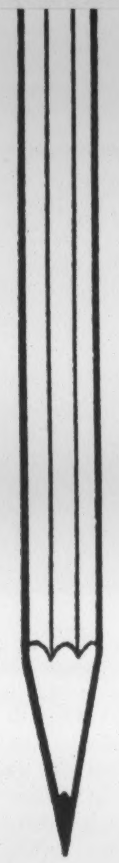


the last word

Thoroughness

Most people who have been in close contact with the International Nickel Co. through the years know how thorough that company is in its efforts. To show how Inco covers a subject, we must report that the company issued an illustrated brochure telling of the damage done to the Sea Horse Institute at Kure Beach and Harbor Island, N.C., by hurricane *Hazel.* To further illustrate the point we pass on the gist of the last item of the report. While Hazel was blowing the bejabbers out of everything in sight, the pet sea horse at Harbor Island was calmly giving birth to about 200 offspring. Or maybe she was just scared. At any rate the colts of appropriate gender will all be christened Hazel.

For Hard Heads

Recently we came across this startling bit of news. In Toledo, Ohio, the barbers resigned from the AFL, were barred by the CIO and finally wound up as members of the United Mine Workers. We'll not comment further, but haven't you wondered about just which union was most appropriate for some of the barbers you have encountered?

What Next

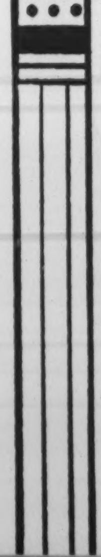
The so-called tin can has been used for many strange things, but one of the most unusual uses has just emerged. A Chicago company is producing a small container which contains an ingenious safety device. Rising ambient temperatures cause internal pressures to build up in the can. When the temperature hits 135 F a fusible link opens and the can lets out a five minute warning wail. At the same time a distinct odor is emitted for the benefit of the hard of hearing. Now if only they could make it sensitive to radioactivity.

Retribution

The advent of electricity, coupled with a few other technological developments, came close to putting the old time whale completely out of business. Rather than retaining an indelible grudge about this situation, the whale is letting bygones be bygones and is now coming to the rescue of the electric lamp. As you know, both copper and aluminum are used for lamp sockets and lamp bases. As sometimes happens an aluminum base will be inserted into a brass socket. Now you have the making of trouble, particularly when moisure is present, for under these conditions the aluminum will be attacked and probably cause the base to stick in the socket. To overcome this troublesome situation, many types of lubricants have been tried to protect the aluminum, but all failed until General Electric scientists tried hydrogenated sperm oil. As someone commented, this bit of scientific research is a whale of a success.

T. C. Du Mond

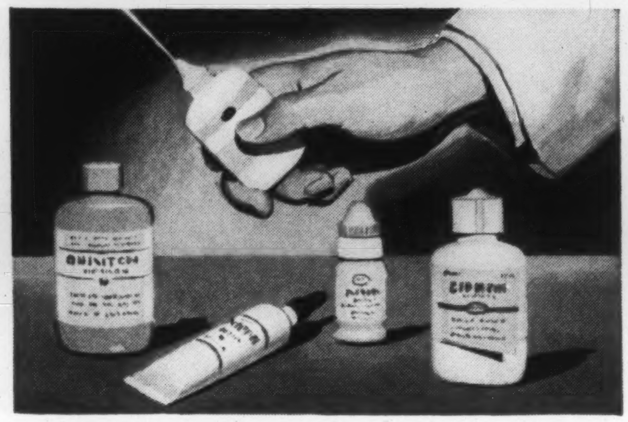
Editor



large

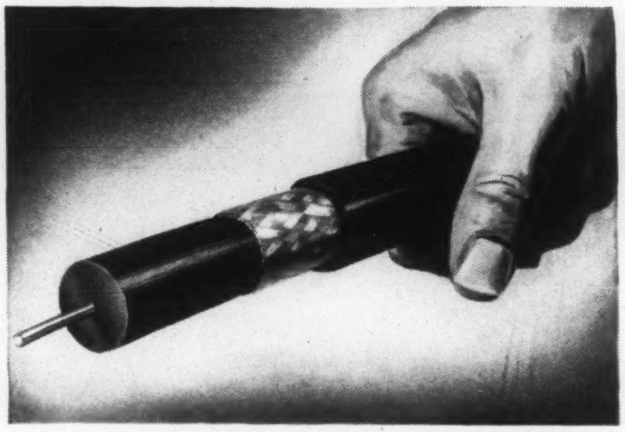
55-gallon drums one-piece molded from Bakelite Polyethylene are designed to fit in standard fiber, plywood, or steel overpacks. Chemically inert, they resist acids, caustic soda solutions, electrolytic fluid. Resilient, non-shattering, lightweight, they increase safety, cut shipping costs.

small



Tubes and bottles molded from Bakelite Polyethylene dispense their chemical and pharmaceutical contents when squeezed. Inherently flexible, polyethylene needs no plasticizer. It won't contaminate contents. Tube ends are closed by heat-sealing.

thick



Coaxial cable has thick layer of Bakelite Polyethylene around center conductor and covered by outer conductor. Tough, flexible, and possessing excellent electrical insulating qualities at high frequencies, polyethylene insulates conductors and keeps them correctly spaced. Other extrusions include belts, tapes, tubes, farm water pipe.

or thin

Liquids are being packed in laminations of cellophane or foil with film made from Bakelite Polyethylene. Advantages: added toughness and tear strength, heat-sealing to a strong, watertight bond, and resistance to food and other chemicals.

add a new dimension to product planning—

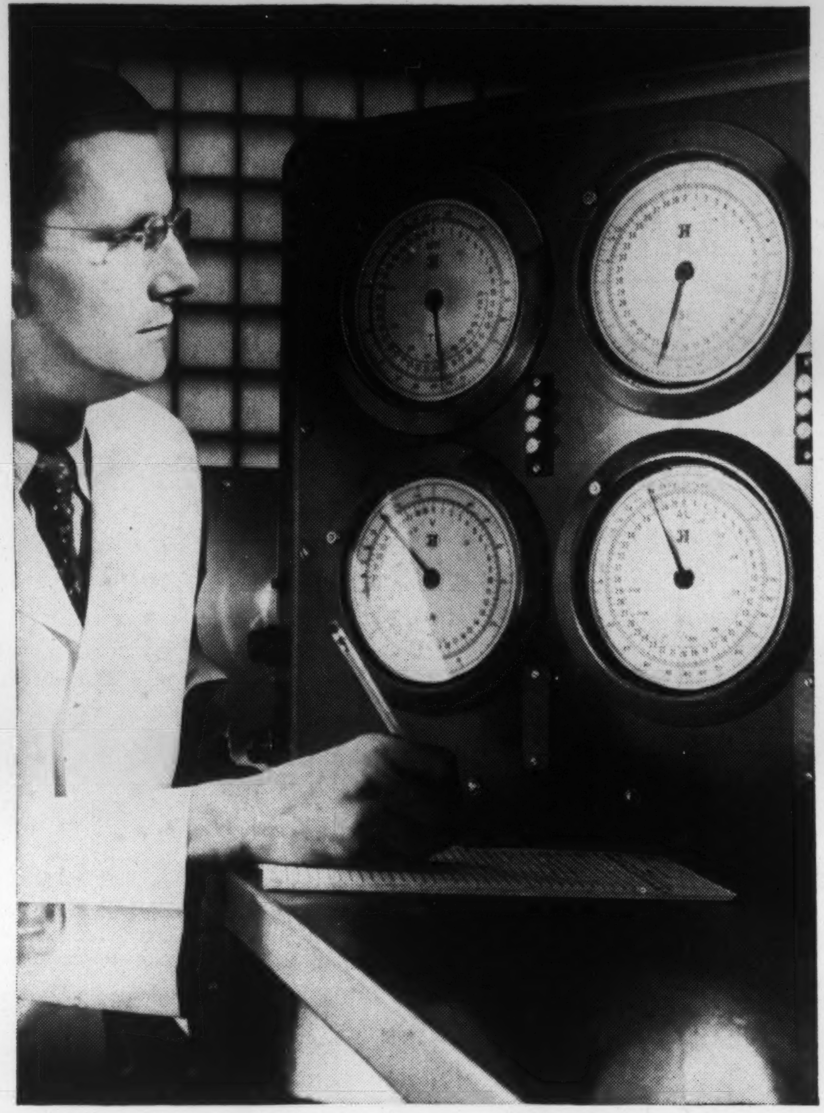
BAKELITE Polyethylene

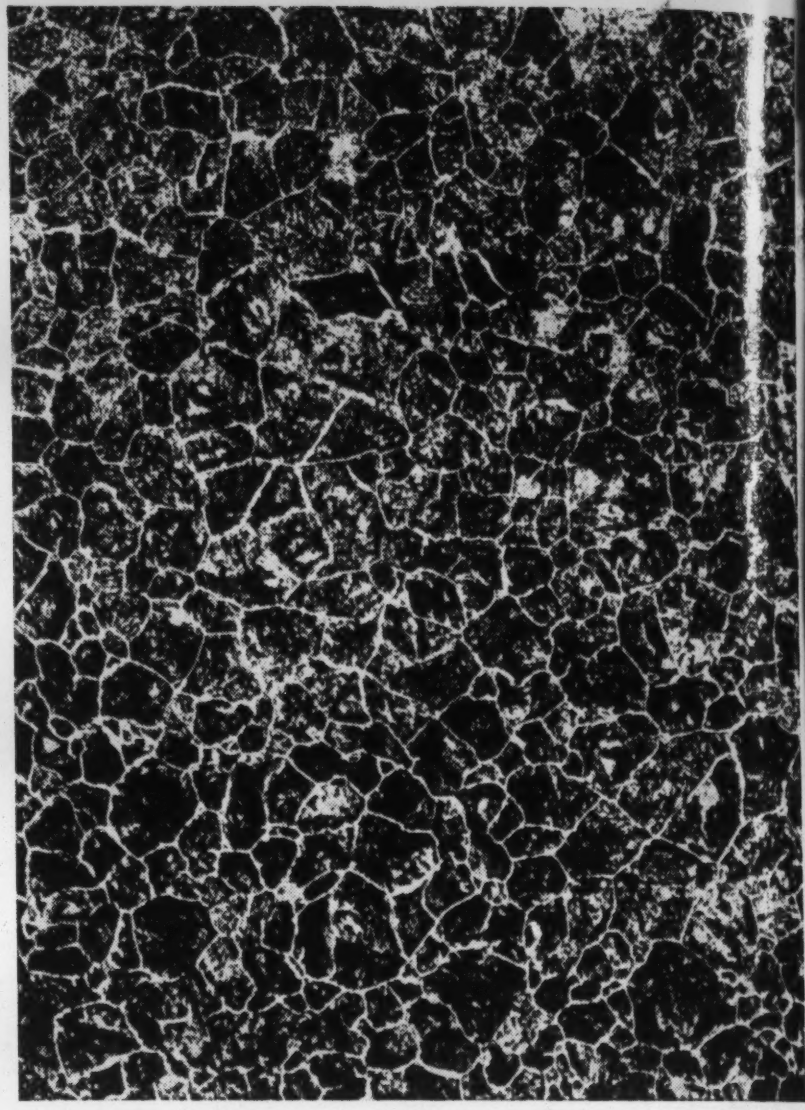
TRADE-MARK

Open a new range of performance features for your product. Give it advantages that mean greater sales. Take your pick of fabrication methods – injection molding, extrusion, calendering, coating, vacuum-forming. Bakelite Polyethylene is packed with possibilities—and it's in plentiful supply right now. The first step in your planning is to learn more about it by writing Dept AI-17.

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

For more information, turn to Reader Service Card, Circle No. 459





Meet two of the reasons why TIMKEN® forging steels give you uniform, high-quality forgings

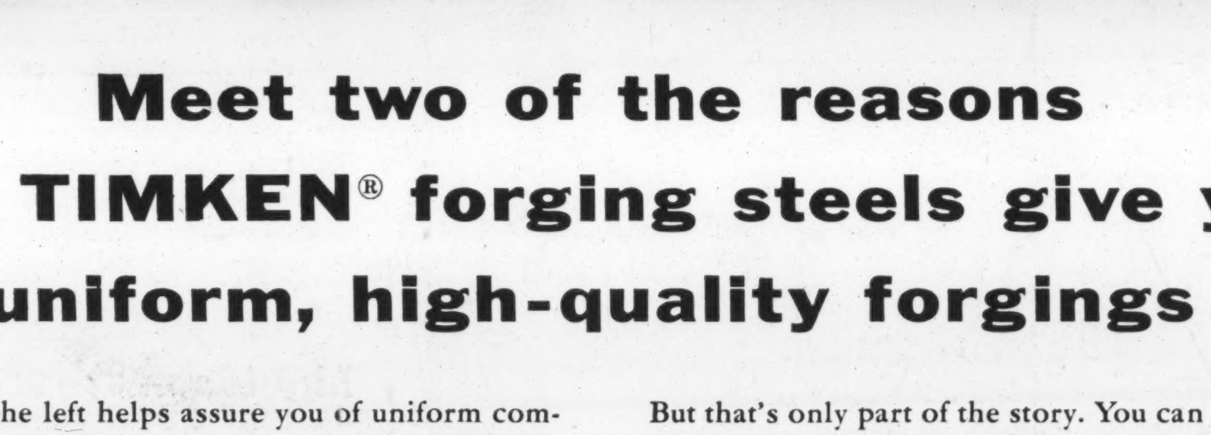
THE man on the left helps assure you of uniform composition in every Timken® steel forging bar. With this spectrometer, he can tell the exact composition of a melt in just 40 seconds. Results are flashed back to the furnace so the melter can maintain constant control of the heat analysis up to the instant of pouring.

The photomicrograph at right shows the uniform grain size of the Timken forging steels. Uniform grain size after heat treatment is assured by spectrometric or microscopic examination of every heat. The result—you can be sure that forgings made from Timken forging steels have uniformly high ductility and resistance to impact.

But that's only part of the story. You can hold rejects to a minimum because we condition the steel to fit your particular forging requirements. And you save steel because the good dimensional tolerances of Timken forging steels produce uniform weight multiples with a minimum of steel lost in flashings. You even have fewer furnace adjustments because Timken forging steels respond uniformly to heat treatment.

For help in improving the quality of your forgings and cutting production costs, write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



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